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NINETY PERCENT SUBMITTAL

PLANS & SPECIFICATIONS FOR REMEDIAL DESIGN/ REMEDIAL ACTION

DETREX CORPORATION SOURCE CONTROL AREAS ASHTABULA, OHIO

Prepared for
Detrex Corporation
1100 North State Road
Ashtabula, OH 44004

February 17, 2000

URS Greiner Woodward Clyde
30775 Bainbridge Road, Suite 200
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February 17, 2000
8E06011

Ms. Terese VanDonsel
United States Environmental Protection Agency
Office of Superfund, Region 5
SR-6J
77 West Jackson
Chicago, IL 60604-3590

Submitted Via Federal Express

Subject: Transmittal of 90% Remedial Design
Fields Brook Superfund Site
Detrex Source Area - Ashtabula, Ohio

Dear Ms. VanDonsel:

On behalf of the Detrex Corporation, URS Greiner Woodward Clyde (URSGWC) is submitting six (6) copies of the 90% Remedial Design for the Detrex Source Area.

The 90% Remedial Design submittal consists of Specifications and Drawings and includes the following attachments:

- Attachment 1 Construction Quality Assurance Plan Objectives
- Attachment 2 Project Schedule
- Attachment 3 Estimated Project Costs
- Attachment 4 Copies of Geotechnical Testing Data
- Attachment 5 Community Relations Support Plan

This submittal does not include Sheet C-6, *Groundwater Contour Map*. This drawing will be submitted under separate cover during the week of February 21, 2000.

If you have any questions regarding this submittal, please do not hesitate to contact me at 440/349-2708.

Sincerely,

URS Greiner Woodward Clyde

Martin L. Schmidt, Ph.D.
Project Manager

Enclosure

cc: Regan Williams – OEPA
Issa Shamiyeh - Detrex Corporation
Charles Guy - Detrex Corporation
Tom Steib - Detrex Corporation

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SPECIFICATIONS

DIVISION 1
General

SECTION 01010
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Site Description
B. Scope of Work
C. Schedule of Work

1.2 RELATED SECTIONS

All sections contained in this document.

1.3 SUBMITTALS

Selected contractor will be required to submit a schedule for completion of the work activities described in this document. This schedule shall coincide with the milestone activities described in the schedule included in Attachment 2.

1.4 SITE DESCRIPTION

The Detrex Corporation facility (the Site) is located in Ashtabula, Ohio. The Site is situated on State Road, approximately 0.50 miles east of U.S. Route 11. The Site is a chemical manufacturing facility and is currently in use. Dense Non-Aqueous Phase Liquid (DNAPL) is present beneath some sections of the site. These materials pose recontamination concerns to both the Fields Brook sediments, located at the southern Site boundary and the DS Tributary sediments, located at the northern site boundary. A DNAPL plume has been identified near the northern property boundary. In addition, a spent catalyst pile area has been identified near the Fields Brook.

1.5 SCOPE OF WORK

A. Work activities include the following:
   1. Vertical Barrier Wall- Placement of a vertical, soil-bentonite barrier wall along the leading edge of the dissolved phase plume along the western border of Detrex property, including beneath an active rail spur and on the adjoining RMI Sodium property to the north;
   2. Groundwater Collection Trench – Installation of a groundwater collection trench along the upgradient side of the slurry wall barrier to intercept

groundwater flow and route it via gravity to a pump station for the existing Detrex water treatment system

3. Interceptor Trench beneath the DS Tributary – Installation of a groundwater interceptor trench to prevent discharge of shallow groundwater to surface water. This Trench will discharge into the groundwater collection trench described above;
4. Catalyst Pile Removal - Excavation and removal of spent catalyst materials located along the edge of the floodplain in EU-8, north of Fields Brook; and,
5. Re-Grading - Filling, re-grading and surface restoration in portions of the site to control stormwater runoff and minimize erosion and sedimentation.

B. The selected contractor will furnish all labor, supervision, permits, materials, equipment, tools, services and incidentals required to complete the Work required by these Specifications, Drawings, and attached Contract Documents. The Work shall be as specified herein and as shown on the Drawings. After completion of the Work, and upon demobilization, the Contractor shall leave the Site free of Contractor's structures, equipment, and debris.

C. In general, work shall include, but not be limited to, the following:

1. Provide all warranties, bonds, insurance and other contract documents required.
2. Provide all required plans and documents, including, but not limited, to:

   a. Construction Schedule
   b. Erosion and Sediment Control Plan
   c. Contaminated Materials Handling Plan
   d. Quality Control Plan
   e. Contingency Plan

3. Furnish required temporary facilities, utilities and site security.
4. Obtain all required permits.
5. Provide all required project record drawings and other documentation as required in these specifications.

1.4 SCHEDULE OF WORK

A. The Contractor is advised that time is of the essence and that work under this Contract shall proceed as expeditiously as possible.

B. All work shall be scheduled and completed as noted in the attached Schedule (Attachment 2)

C. The sequence and schedule of construction is subject to the approval of the Engineer and shall adhere, at a minimum to the following project milestones:

1. **Contractor Selection** ..... **April 20, 2000**
2. **Notice to Proceed** ..... **April 27, 2000**
3. **Completion of all Seeding** ..... **October 15, 2000**
4. **Substantial Completion** ..... **October 15, 2000**
5. **Completion of slurry wall, groundwater collection, excavation, regrading and Demobilization** ..... **November 1, 2000**

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01010

SECTION 01020
SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Obstructions
B. Open Excavation
C. Construction Water Management
E Public Nuisance
F. Permits
G. Traffic Control
H. Working Hours

1.2 RELATED SECTIONS

A. Section 01030 - Contractor Safety and Health
B. Section 01320 - Submittals

1.3 SUBMITTALS

A. Submit in accordance with Section 01030.
B. Submit in accordance with Section 01320
C. Permits and permit correspondence

1.4 OBSTRUCTIONS

A. The Contractor shall verify the location of all utilities located within the areas of the Work and protect them from construction related activities, as specified in the Contract Documents. Should damage occur to an existing utility, the Contractor shall repair the utility at no cost to the Owner.

1.5 OPEN EXCAVATIONS

A. All open excavation work shall be completed in compliance with OSHA 29 CFR 1926 Subpart P.

B. All trenches, excavated material, equipment, or other obstacles outside the limits of the secured perimeter, which could be dangerous to the public, shall be barricaded with flashers and well lighted at night. The Contractor is responsible for, at a minimum, maintaining and providing the barricades and lights.

1.6 CONSTRUCTION WATER MANAGEMENT

A. Water shall be handled using equipment and containers compatible with the contaminants identified on the site, as specified in the Site Health and Safety Plan.

1.7 PUBLIC NUISANCE

A. The Contractor shall not create a public nuisance including, but not limited to, encroachment on adjacent lands not included in the scope of work, as shown on the Contract Drawings, flooding of adjacent lands, or excessive noise.

B. No extra charge may be made for time lost due to work stoppage resulting from the Contractor's creation of a public nuisance.

1.8 PERMITS

A. Where required under applicable regulations, the Contractor shall obtain and pay for all necessary permits, approvals and bonds. The Contractor shall advise the Engineer in advance, of his intention to conduct or attend any meetings, apply for any permits/approvals or post any bonds with the governing agencies. The Contractor shall submit all acquired permits and copies of all his correspondence with the agencies to the Engineer.

1.9 TRAFFIC CONTROL

A. The Contractor shall:
1. Not cause traffic conflicts in the public roadway rights of way.
2. Designate construction personnel parking area such that interference with public traffic is prevented and access for emergency vehicles are maintained.
3. Prevent parking on or adjacent to access roads or in non-designated areas.
4. Maintain all public non-truck routes in their pre-construction condition.
5. Provide trained and equipped flagmen to regulate traffic when construction operations or traffic encroach on public traffic lanes.
6. Use lights to guide traffic during hours of low visibility.

B. All work on public roads shall conform to the regulations of the Ohio Department of Transportation (ODOT) and the Ashtabula County Engineer's office.

1.10 WORKING HOURS

A. Regular working hours are defined as 7:00 a.m. to 6:00 p.m., Monday through **Friday or Saturday.**

B. Contractor shall be prepared to work 24 hours per day, if necessary, to minimize the duration of time the rail spur is out of service during construction activities, including

excavation of the DS Tributary and crossing of the rail spur with the slurry wall and the upgradient groundwater collection trench.

C. Requests to work other than regular working hours must be submitted to the Owner, at least 48 hours prior to such proposed work, to give the Owner ample time to arrange for representation and/or inspection during those periods. Periodic unscheduled overtime on weekdays will be permitted provided that two hours notice is provided to the Owner. Maintenance and cleanup may be performed during hours other than regular working hours subject to approval by the Engineer and provided that it does not cause a nuisance to the public.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01020

SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Measurement and payment criteria applicable to the Work performed under a combined Lump Sum and Unit Price payment method.

B. Defect assessment and non-payment for rejected work.

1.2 RELATED SECTIONS

A. Section 02110 – Site Clearing

B. Section 02168 – Soil-Bentonite Slurry Wall

C. Section 02200 – Excavation and Backfill

D. Section 02618 – Culverts

E. Section 03300 – Cast in Place Concrete

F. Section 03400 – Pre-Cast Concrete

G. Measurement methods delineated in the individual specification sections are intended to complement the criteria of this section. In the event of conflict, the requirements of the individual specification section shall govern.

1.3 AUTHORITY

A. The Contractor shall take all measurements and compute quantities. All payment item measurements shall be computed based on field survey of complete work, as finally accepted.

1.4 UNIT QUANTITIES SPECIFIED

A. Quantities and measurements indicated in the Bid Schedule are for bidding and contract purposes only. Quantities and measurements supplied or placed in the work and verified by the Engineer will determine payment.

B. If the actual work requires more or fewer quantities than those quantities indicated, the Contractor shall provide the required quantities at the unit sum/prices contracted.

1.5 MEASUREMENT OF QUANTITIES

A. Measurement by volume: Measured by cubic dimension using mean length, width, and height or thickness.

B. Measurement by area: Measured by square, in-place, horizontal projection dimensions using mean length and width or radius.

C. Linear measurement: Measured by linear dimension, at the item centerline or mean chord.

D. Stipulated sum/price measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed items or unit of the Work.

1.6 NON-DIRECT PAYMENT

A. The Contractor is advised that while specifically required or called for by the Contract Documents, no direct payment will be made for:

1. Special controls
2. Dust control
3. Supervision
4. Home office support
5. Equipment maintenance
6. Construction photographs
7. Laboratory testing
8. Restoration of areas, outside the limits of work, damaged by the Contractor
9. Protection of partially-completed work
10. Health and Safety
11. Survey
12. Equipment decontamination
13. Site security

The costs of this work, and any others not specifically identified, shall be included in the unit prices bid for the various items in the contract.

1.7 PAYMENT

Measurement and payment for items listed in Bid Schedule shall be as defined in the following bid items.

A. Item 1 - Insurance, Bonds, and Permits:

1. Basis of Measurement: Measurement of this item shall be the satisfactory acquisition of all required insurance, bonds, and permits that are required for the completion of the Work. Payment will be made at the Contract Lump Sum Price.

2. Basis of Payment: Payment may be made on a partial completion basis if approved by Engineer.

B. Item 2 - Mobilization

1. Basis of Measurement: The measurement of this item shall be the completed delivery and setup of equipment and facilities, including, but not limited to:

   a) Delivery of Contractor required submittals for review and/or approval by the Engineer.

   b) Attendance at the preconstruction meetings.

   c) Mobilization of all construction equipment, tools, and appurtenances staffed and ready for performing the Work.

   d) Delivery of materials and supplies needed for initiation of the Work but not included and paid elsewhere.

   e) Contractor required services, including, but not limited to telephones, electricity, water, and sanitary services.

   f) Related costs associated with the installation of field offices.

2. Basis of Payment: Payment will be made at the Contract lump sum price as full compensation for all required work. Payment for this item cannot exceed two and one-half (2 ½) percent of the total bid price. Payment may be made on a partial completion basis if approved by Engineer. Payment of this item will not be made until five (5) percent of the total of all items of work is complete and acceptable to the Engineer and Owner. Delays and extensions of time shall not entitle the Contractor to additional compensation for this pay item.

C Item 3 – Demobilization

1. Basis of Measurement: Demobilization includes removal of all construction equipment, removal of temporary facilities and utilities, and any other closeout

activities not included for payment elsewhere. The Contractor shall be paid for one demobilization only.

2. Basis of Payment: Payment under this item will be a lump sum as full compensation for performing all demobilization activities.

This item shall not be less than one-half of one percent of the total bid price. Delays and extensions of time shall not entitle the Contractor to additional compensation for this pay item.

D. Item 4 – Regrading

1. Basis of Measurement – The measurement for this item shall be the volume of excavation. Measurement shall be by survey of the cubic yards of materials in-place prior to and after excavation. All areas and volumes surveyed for measurement and payment shall be based on horizontal projections. No adjustment in quantity shall be made for slopes.

2. Basis of Payment – The unit price for this item shall be full compensation for furnishing all labor, materials and equipment required to achieve final grade elevations. This item shall also include all labor, materials and equipment necessary to complete work including but not limited to environmental protection controls. The unit price shall include all costs associated with doing the grading with personnel in the appropriate Level personal protective equipment, in accordance with Contractor's Health and Safety Plan.

E. Item 5 – General Fill

1. Basis of Measurement – The measurement for this item shall be the actual number of cubic yards of compacted general as measured by survey prior to and after placement. All areas and volumes surveyed for measurement and payment shall be based on horizontal projections. No adjustment in quantity shall be made for slopes.

2. Basis of Payment – The unit price bid for this item shall be full compensation for labor and equipment to transport, and place the general fill in accordance with the project requirements.

F. Item 6 – Groundwater Collection System

1. Basis of Measurement – The measurement for these items shall be the linear feet of trench constructed in accordance with project requirements. Measurement shall be by survey, along the centerline of the pipe component of the trench. Solid drain outlet pipes shall also be included in the measurement. All lengths and volumes surveyed for measurement and payment shall be based on horizontal projections. No adjustment in quantity shall be made for slopes.

2. Basis of Payment – The unit price for this item shall be full compensation for furnishing and installing all labor, material, and equipment to construct the trenches. The price shall include, but shall not be limited to, perforated and solid pipe, connections, fittings, aggregate bedding and backfill, overlying geomembrane in the DS Tributary, and any additional excavation or backfill which may be required.

G. Item 7 – Topsoil

1. Basis of Measurement – The measurement for this item shall be for the actual approved number of acres covered with a minimum of 6 inches of amended topsoil as shown, specified or directed. Measurement will be by survey of the actual approved area rounded to the nearest tenth of an acre. All areas and volumes surveyed for measurement and payment shall be based on horizontal projections. No adjustment in quantity shall be made for slopes.

2. Basis of Payment – The unit price for this item shall be full compensation for furnishing and installing all labor, materials, tools, equipment and appurtenances necessary to complete the work including but not limited to excavating, stockpiling and transporting the material. The unit price shall include placing and spreading topsoil, and raking or screening the topsoil to remove large or otherwise objectionable materials as shown, specified, or directed. The unit price shall include the required laboratory testing and the amendment of the soil based on the laboratory test results. For the purposes of the bid, the contractor shall price the cost of providing and placing the following amendments:

   - Agricultural lime – 2 tons/acre
   - 10-20-10 fertilizer – 600 lbs./acre

Additional or reduced costs shall be negotiated/adjusted by change order subsequent to soil testing and amendment testing by the Contractor's laboratory. The Contractor will not be entitled to additional compensation for maintenance and repair/restoration of areas of topsoil disturbed, washed out, eroded, or otherwise not approved between the time of placement to the actual acceptance of the entire project by the Owner.

H. Item 8 – Seeding of Area

1. Basis of Measurement – The measurement for this item shall be the actual number of vegetated acres or fraction to the nearest tenth of an acre as measured by survey after seeding and establishment of acceptable vegetation within the limits shown. The Contractor shall not be compensated for the seeding and restoration of areas outside the specified limits. All areas and volumes surveyed for measurement and payment shall be based on horizontal projections. No adjustment in quantity shall be made for slopes.

2. Basis of Payment – The unit price for this item shall be full compensation for furnishing and installing all labor, materials, tools, equipment and appurtenances necessary to complete the work including but not limited to obtaining seed, mulch, water, protecting, testing, watering, necessary replacement, as shown, specified, or directed. There shall be no partial acceptance of the vegetation. The Contractor shall not be entitled to additional compensation for maintenance and repair/restoration of seeding areas disturbed, washed out, eroded, dead, bare, or otherwise not accepted between the time of placement and the final acceptance of the entire project by the Owner.

I. Item 9 – Erosion and Sediment Control at Regrading Areas

1. Basis of Measurement – The measurement of these items will be the satisfactory furnishing (as determined by the Engineer) of all controls as specified on the Contract Documents. The work shall include but not be limited to preparation of an Erosion and Sedimentation Control Plan, minimizing water and silt, etc. from running off the project site or from entering work areas. This item shall include providing, installing, and maintaining silt fences, silt booms, hay-bale dikes, temporary basins and other features required to meet project specifications and the Contractor's approved Erosion and Sedimentation Control Plan.

2. Basis of Payment – The lump sum price bid for this item shall be full compensation for furnishing and installing all labor, materials, equipment and control features as required by the Contract Documents. Progress payments shall be made based on the project schedule and work performed.

J Item 10 – Equipment Decontamination

1. Basis of Measurement – The measurement of this item shall be the satisfactory decontamination (including documentation) of all construction equipment prior to demobilization from the site and the maintenance and final cleanup of the Owner's decontamination pad.

2. Basis of Payment – Payment under this item shall be lump sum as full compensation for all required material, equipment, and labor required to perform the work. No progress payments will be made for this item. The lump sum shall be paid after all equipment is properly decontaminated and demobilized from the site and the decontamination pad is cleaned to the Engineer's satisfaction.

K. Item 12 – Project Record Drawings

1. Basis of Measurement – The final measurement of this item shall be the satisfactory preparation, review, and submittal of project record drawings, for the work covered under Section 01710.

2. Basis of Payment – Payment under this item will be a lump sum as full compensation for all required work, including record red-line drawings and supplemental record drawings. Progress payments will not be made on this item. The lump sum will be paid after the final drawings are accepted.

The price for this item shall equal a minimum of 2 ½ percent of the total bid price.

1.8 DEFECT ASSESSMENT

A. Replace the work, or portions of the work, not conforming to the specified requirements in the Drawings and Specifications.

B. If, in the opinion of the Engineer, it is not practical to remove and replace the Work, they will direct one of the following remedies:

1. The defective work may remain, but the unit sum/price will be adjusted to a new sum/price at the discretion of the Engineer.

2. The defective work will be partially repaired to the instruction of the Engineer, and the unit sum/price will be adjusted to a new sum/price.

C. The individual specification sections may modify these options or may identify a specific formula or percentage sum/price reduction.

D. The authority of the Engineer to assess the defect and identify payment adjustment is final.

1.9 NON-PAYMENT FOR REJECTED PRODUCTS

A. Payment will not be made for any of the following:

1. Products wasted or disposed of in a manner that is not acceptable.
2. Products determined as unacceptable before or after placement.
3. Products not completely unloaded from the transporting vehicle.
4. Products placed beyond the lines and levels of the required work.
5. Products remaining on hand after completion of the work.
6. Loading, hauling, and disposing of rejected products.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01025

SECTION 01030
CONTRACTOR SAFETY AND HEALTH

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. This section specifies the minimum requirements for safety, health, and emergency response for the project. A site specific Health and Safety Plan (Site HASP) for the Detrex site has currently been prepared and is available for review by the Contractor.

B. The Contractor shall develop his own written Health and Safety Plan (Contractor HASP) to address health and safety issues related to the performance of work described in these specifications. The Contractor HASP shall also be developed to comply with all applicable federal, state, and local regulations.

1.2 RELATED SECTIONS

A. All Work related sections contained in this document.

1.3 SUBMITTALS

A. The Contractor shall submit two (2) copies of the Contractor HASP to the Engineer at least 2 weeks prior to commencement of field activities. The Contractor HASP will be reviewed by the Engineer to ensure that site specific Health and Safety issues have been addressed.

B. Contractor shall submit copies of current training certification statements for all personnel working at the Site. Such documentation should be included as part of the Contractor HASP.

1.4 REGULATORY REQUIREMENTS

A. Work performed under this contract shall comply with applicable federal, state, and local safety and occupational health laws and regulations. This includes, but is not limited to, Occupational Safety and Health Administration (OSHA) standards 29 CFR Part 1910, especially Section .120, "Hazardous Waste Site Operations and Emergency Response" and 29 CFR Part 1926, especially Section .65, "Hazardous Waste Site Operations and Emergency Response."

B. The program requirements of the OSHA Standards shall be integrated into a site-specific Health and Safety Plan (HASP). The HASP shall interface with the Contractor's overall Health and Safety Program. Any portions of the overall Health and Safety Program that are referenced in the HASP shall be included as appendices to the HASP.

The HASP shall be made available in accordance with 29 CFR Part 1910, Section .120 (b) (1) (v) and 29 CFR Part 1926, Section .65 9 (b) (1)(v).

1.5 HEALTH AND SAFETY PROGRAM

A. OSHA Standards 29 CFR Part 1910, Section .120 (b) and 29 CFR Part 1926, Section .65 (b) require employers to develop and implement a written Health and Safety Program for employees involved in hazardous waste operations.

1.6 TRAINING

A. All personnel shall receive training in accordance with the Contractor's written health and safety training program and 29 CFR Part 1910, Section .120, 29 CFR Part 1926, Section .65, and 29 CFR Part 1926 Section .21. At a minimum, all personnel shall have the minimum training described below:

1. General Operations Training:

Personnel entering the Exclusion or Contamination Reduction Zones shall have successfully completed 40 hours of hazardous waste instruction off the site; three (3) days actual field experience under the direct supervision of a trained, experienced supervisor; and 8 hours refresher training annually. Onsite supervisors shall have completed the above training and 8 hours of additional, specialized training covering at least the following topics: the employer's Health and Safety Program, personal protective equipment program, spill containment program, and health hazard monitoring procedures and techniques.

All employees who are required to supervise, standby, or enter permit-required confined spaces shall have been trained as specified by 29 CFR Part 1910, Section .146. Persons involved in any aspect of the transportation of hazardous materials shall be trained in accordance with 49 CFR Part 172, Subpart H.

2. Site-Specific Training:

Prior to commencement of onsite field activities, all site personnel, including those assigned only to the Support Zone, shall attend a site-specific health and safety briefing. This session shall be conducted by the Health and Safety Manager and the Site Health and Safety Officer to ensure that all personnel are familiar with requirements and responsibilities for maintaining a safe and healthful work environment. Procedures and contents of the accepted HASP shall be thoroughly discussed for documentation purposes, a roster sheet shall be completed which contains the names and signatures of all participants. The Engineer and Owner shall be notified at least five days prior to the initial site-specific training session so personnel involved in the project may attend.

3. Periodic Sessions

A briefing shall be conducted by the Site HSO daily for personnel assigned to work at the site. The training shall address safety and health procedures, work practices, any changes in the HASP, activity hazard analyses, work tasks or schedule, results of previous week's air monitoring, review of safety discrepancies, and accidents. Should an operational change affecting onsite field work be made, a meeting prior to implementation of the change shall be convened to explain health and safety procedures. Site-specific training sessions for new personnel, visitors, and suppliers shall be conducted by the Site HSO using the training curriculum outlines developed by the Health and Safety Manager. All sessions shall be documented by completion of roster sheets.

1.7 PPE For Owner/Regulatory Agency Personnel

A. Five clean sets of personal protective equipment and clothing (excluding air-purifying respirators and safety shoes, which must be provided by individual visitors), as required for entry into the Exclusion Zone and/or Contamination Reduction Zone, shall be available for use by the Owner or official visitors. The items shall be cleaned and maintained by the Contractor. The Contractor shall provide basic training in the use and limitations of the PPE provided, and institute administrative controls to check prerequisites prior to issuance. Such prerequisites include meeting minimum training requirements for the work tasks to be performed and medical clearance for site hazards and respirator use.

1.8 Certificate of Worker/Visitor Acknowledgment

A. A Contractor-generated certificate of worker/visitor acknowledgment shall be completed and submitted for each visitor allowed to enter Contamination

Reduction or Exclusion Zones, and for each employee. An example copy of this certificate has been included following the end of this section.

PART II - PRODUCTS

Not used.

PART III - EXECUTION

Not used.

END OF SECTION 01030

EXAMPLE CERTIFICATE OF WORKER/VISITOR ACKNOWLEDGMENT

CONTRACT NO.: _____

PROJECT NAME: _____

PROJECT ADDRESS: _____

CONTRACTORS NAME: _____

EMPLOYEES/VISITORS NAME: _____

The contract for the above project requires the following: that you be provided with and complete formal and site-specific training; that you be supplied with proper personal protective equipment including respirators; that you be trained in their use; and that you receive a medical examination to evaluate your physical capacity to perform your assigned work tasks, under the environmental conditions expected, while wearing the required personal protective equipment. These things are to be done at no cost to you. By signing this certification, you are acknowledging that your employer has met these obligations to you.

I HAVE READ, UNDERSTAND, AND AGREE TO FOLLOW THE SITE HEALTH AND SAFETY PLAN FOR THIS SITE.

Name _____ Date _____

FORMAL TRAINING: I have completed the following training courses that meet the OSHA "HAZWOPER" requirements.

	Date Completed
40-Hour	_____
8-Hour Supervisory	_____
8-Hour Refresher	_____

SITE-SPECIFIC TRAINING: I have been provided and have completed the site-specific training required by this contract. The Site Health and Safety Officer conducted the training. _____

RESPIRATORY PROTECTION: I have been trained in accordance with the criteria in the Contractor's/my employer's Respiratory Protection Program. I have been trained in the proper work procedures and use and limitations of the respirator(s) I will wear. I will abide by policies concerning eyeglasses, contact lenses, and facial hair. _____

RESPIRATOR FIT-TEST TRAINING: I have been trained in the proper selection, fit, use, care, cleaning, maintenance, and storage of the respirator(s) that I will wear. I have been fit-tested in accordance with the criteria in the Contractor's/my employer's Respiratory Protection

Program and have received a satisfactory fit. I have been assigned my individual respirator. I have been taught how to properly perform positive and negative pressure fit-checks upon donning negative pressure respirators each time. _____

MEDICAL EXAMINATION: I have had a medical examination within the last twelve months which was paid for by my employer. The examination included: health history, pulmonary function tests, and may have included an evaluation of a chest x-ray. A physician made a determination regarding my physical capacity to perform work tasks on the project while wearing protective equipment including a respirator. I was personally provided a copy and informed of the results of that examination. My employer's industrial hygienist evaluated the medical certification provided by the physician and checked the appropriate blank below. The physician determined that there:_____

_____ were not limitations to performing the required work tasks;

_____ were identified physical limitations to performing the required work tasks.

Date medical exam completed _____

(Employee's) (Visitor's) Name_____Date _____

(Employee's) (Visitor's) Signature _____Date _____

Social Security Number _____

Site Health and Safety Officer's Signature _____Date _____

SECTION 01210
PROJECT MEETINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Engineer shall schedule and administer a preconstruction conference, periodic progress meetings, and specially called meetings throughout the progress of the work and shall:

1. Prepare agenda for meetings
2. Preside at meetings
3. Prepare and distribute meeting minutes

B. The Engineer, Contractor, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. The Contractor shall attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.

D. The Contractor shall arrange and conduct Health and Safety briefings as described in the Health and Safety Plan.

1.2 RELATED SECTIONS

A. Section 01030 – Contractor Safety and Health

B. Section 01380 - Construction Photographs

C. Section 01700 – Work Closeout

D. Section 01710 – Project Record Documents

1.3 PRECONSTRUCTION CONFERENCE

A. The Contractor shall attend a scheduled preconstruction conference.

B. The location of the preconstruction meeting shall be at a site convenient for all parties, as designated by the Owner.

C. Parties responsible for attending the preconstruction meeting are:

1. The Owner
2. The Engineer
3. The Contractor's Superintendent, Site Health and Safety Officer, and others, as appropriate
4. Major subcontractors

5. Regulatory agency personnel, as required
6. Others as appropriate

D. The purpose of the pre-construction conference will be to establish relationships among all parties involved in the remedial action, including lines of communication, lines of authority, and scope of work. The suggested agenda is as follows:

1. Distribution and discussion of:
   a. List of major subcontractors and suppliers
   b. Projected construction schedules
2. Critical work sequencing
3. Major equipment deliveries and priorities
4. Project coordination
   a. Designation of responsible personnel
5. Procedures and processing of:
   a. Field decisions
   b. Proposal requests
   c. Submittals
   d. Change Orders
   e. Applications for Payment
6. Adequacy of distribution of Contract Documents
7. Procedures for maintaining record documents
8. Use of premises:
   a. Office, work and storage areas
   b. Coordination with the Owner's operations
9. Construction facilities, controls and construction aids
10. Temporary utilities
11. Housekeeping procedures
12. Check of required bond and insurance certifications
13. Liquidated damages
14. Laboratory testing of material requirements
15. Inventory of material stored on site provisions
16. Verification of cleanup and change orders for additional work
17. Health and Safety Plan
18. Construction Quality Assurance
19. Public relations issues
20. Coordination with local governments
21. Permitting requirements
22. Access issues

1.4 PROGRESS MEETINGS

A. Contractor shall schedule regular progress meetings. The progress meetings will be held every 14 days or less with the first meeting 14 days after the pre-construction meeting or 14 days or less after the date of Notice to Proceed.

B. Hold specially called meetings as required by progress of the Work.

C. Location of the meetings: Project field office of Engineer.

D. Attendance:

1. Owner's representative
2. Engineer
3. Regulatory Agency personnel, if applicable
4. Contractor's Superintendent, Health and Safety Officer, and others as appropriate
5. Subcontractors as appropriate to the agenda
6. Suppliers as appropriate to the agenda
7. Others as appropriate

E. Suggested Agenda:

1. Review, approval of minutes of previous meeting
2. Review of work progress since previous meeting
3. Field observations, problems, conflicts
4. Problems which impede construction schedule
5. Review of off-site fabrication, delivery schedules
6. Corrective measures and procedures to regain projected schedule
7. Revisions to construction schedule
8. Progress, schedule, during succeeding work period
9. Coordination of schedules
10. Review submittal schedules; expedite as required
11. Maintenance of quality standards
12. Pending changes and substitutions
13. Review proposed changes for effect on construction schedule and completion date
14. Matters related to Health and Safety Plan and emergency response and contingency planning
15. Quality assurance procedures
16. Public relations

17. Other business

F. The Contractor is to attend progress meetings and is to study previous meeting minutes and current agenda items, in order to be prepared to discuss pertinent topics such as deliveries of materials and equipment, and progress of the work.

G. The Engineer shall keep an accurate account of all meetings in a "meeting minutes" form and distribute to the attendees within five (5) days of the meeting.

1.5 SUBMITTALS

A. Contractor shall submit one (1) original and two (2) copies of the construction schedule to the Engineer before each progress meeting:

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01210

SECTION 01380
CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Photography Required;

B. Submittals;

C. Prints; and

D. Views Required.

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work.

B. Section 01710 - Project Record Documents.

1.3 PHOTOGRAPHY REQUIRED

A. The Contractor shall employ a photographer to take preconstruction photographs and video of all construction areas and the construction vehicle access route prior to start of work, periodically during the course of the work and after the work is completed.

B. The Contractor shall furnish a good quality 35-mm camera, film, and photographs as specified in this section to record the important features of the site prior to the commencement of work, during construction, and after the work has been completed. Three copies of all photographs shall be provided to the Engineer.

C. Before work begins, the Contractor shall take a minimum of 48 color exposures of the general site showing the locations where major project activities will occur, including, but not limited to: the Slurry Wall Alignment, the rail spur crossing, the DS Tributary, the State Road crossing, the Groundwater Collection Trench Alignment, the Catalyst Pile Area, and the various areas to be regraded. Contractor chosen locations shall be confirmed by the Engineer. The prints shall be 3 x 5 or 4 x 6 inches.

D. Photographs taken in conformance with this Section shall be furnished to the Engineer with each Application for Payment.

E. A minimum of 25 color exposures shall be taken at least once each month during project activities and at each of the major stages of work.

F. After completion of work, the Contractor shall take a minimum of 48 color exposures of the completed site at the general locations shown in the preconstruction photographs.

G. Negatives.

1. The photographer shall release all negatives to the Engineer following job completion.
2. Photographer shall agree to furnish additional prints to the Engineer at commercial rates in effect at time of purchase.

1.4 SUBMITTALS

A. The Contractor shall submit two copies of any color audio-video tapes taken to the Engineer with Project Record Documents.

B. The Contractor shall deliver prints to the Engineer to accompany each Application for Payment.

C. The Contractor shall submit all negatives to the Engineer upon submittal of the Project Record Documents.

PART 2 - PRODUCTS

2.1 PRINTS

A. Color:

1. Paper: Single weight, color print paper
2. Finish: Smooth surface, glossy
3. Size: As previously described

B. Identify each print on back with waterproof, smearproof black ink, listing:

1. Name of Contract.
2. Orientation of view.
3. Date and time of exposure.
4. Name and address of photographer.
5. Photographer's numbered identification of exposure.

PART 3 – EXECUTION

3.1 TECHNIQUE

A. Factual presentation

B. Correct exposure and focus

1. High resolution and sharpness
2. Maximum depth-of-field
3. Minimum distortion

3.2 VIEWS REQUIRED

A. Prints and video film shall illustrate condition and location of work and the state of progress.

B. At successive periods of photography, the Contractor shall take at least four photographs from consistent vantage points to provide the same views (and progression of work) throughout the project duration. These prints will be 5 x 7 inches.

C. Contractor shall confirm selection of views with the Engineer prior to each period of photography.

END OF SECTION 01380

SECTION 01510
TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, heating and ventilation, air conditioning, telephone, sanitary facilities, and water.

1.2 RELATED SECTIONS

A. Section 01030 - Contractor Safety and Health

B. Section 01590 - Field Offices and Temporary Facilities

1.3 REFERENCES

A. National Electric Code (Latest Edition)

1.4 TEMPORARY ELECTRICITY AND LIGHTING

A. Contractor shall arrange with Owner and the local utility company to obtain electrical service required for power and lighting. Contractor will be responsible for payment of all costs associated with installation, maintenance, and removal of temporary electrical service. Owner will provide payment for service costs.

B. Electrical power may be used to power the batch mix plant, field offices, decontamination trailers, and ancillary equipment associated with construction activities and site security.

1.5 TEMPORARY TELEPHONE SERVICE

A. Telephone service will be available in the Detrex Corporation offices.

B. If necessary, Contractor can arrange with the local telephone service company to provide direct line telephone service to field office trailers.

C. If temporary telephone service is installed, Contractor will be responsible for payment of all costs for installation, maintenance and removal, and service charges for local calls and toll charges.

1.6 TEMPORARY WATER

A. Water service to the site currently does not exist. Owner will allow Contractor the use of existing potable and non-potable process water (ASHCO water) for Contractor's use. Contractor shall be responsible for connection to water supplies and routing of the water to the work area.

B. The Owner shall provide non-potable water for the Contractor's use during the construction of the slurry wall. The non-potable water is available to the Contractor at on-site hydrants.

C. The quantity of water required for equipment and personnel decontamination, dust control, and other site activities shall be determined by the Contractor. Non-potable water outlets, if any, such as for fire fighting purposes, shall be clearly identified, indicating that the water is unsafe, and is not to be used for drinking, washing, or cooking purposes.

D. The Contractor shall provide adequate washing facilities for employees engaged in operations where hazardous substances may be harmful to employees.

1.7 TEMPORARY SANITARY FACILITIES

A. Contractor will provide sanitary facilities for his workers in compliance with laws and regulations.

B. Contractor shall be responsible for the servicing, cleaning, and maintenance of temporary sanitary facilities and enclosures.

1.8 MAINTENANCE

A. Contractor shall be responsible for maintenance and operation of all temporary utilities during use.

B. Contractor shall be responsible for any modifications to temporary utility appurtenances, ensuring compliance with all regulations, and ensuring a safe operation in accordance with the Site Health and Safety Plan and Section 01030 of this document.

1.9 REMOVAL

A. Completely remove temporary utility materials and equipment when their use is no longer required at project completion.

B. Clean and repair damage caused by temporary installations or use of temporary facilities.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 01510

SECTION 01540
SECURITY

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Site security during construction activities.

1.2 RELATED SECTIONS

A. Section 01030 - Contractor Safety and Health

1.3 CONSTRUCTION SITE ENTRANCE CONTROL

A. Contractor shall maintain control of all persons and vehicles entering and leaving the Construction Site, as necessary, to assure integrity of the project and safety. Contractor shall exclude all personnel not properly identified and/or approved for entry.

B. The Contractor shall maintain identification of all construction site workers (including subcontractors) which will include, at a minimum, name, and employer.

C. The Contractor shall maintain a current list of persons approved for access to the construction site.

D. The Contractor shall require personnel to sign in upon entering the construction site and to sign out when leaving.

E. The Contractor shall maintain a list of all vehicles entering and leaving the construction site.

F. No visitors shall be allowed in the construction area without the prior approval of the Engineer. Visitors shall comply with the requirements of Section 01030 – Contractor Health and Safety, and shall not be left unescorted.

G. The Contractor shall maintain a log of all visitors which shall include name, affiliation, and purpose of visit.

H. The Contractor shall require signature of visitors on a form relieving the Engineer and Owner, their officers, employees, and agents of the liability of consequences related to potential hazards associated with construction site entry.

1.4 CONSTRUCTION SITE CONTROL

A. General

1. Owner maintains security and access to the manufacturing portions of the site at all times. Construction activities will occur outside of the Owner-secured manufacturing portions of the site. Securing these areas from unauthorized entry will be the responsibility of Contractor.

2. Maintain control of the construction site and assume responsibility for security. At a minimum, provide security during all working hours (construction operation). Security procedures shall be established on site to log in/log out working personnel at the beginning of each working day and to log out working personnel at the end of each working day.

B. Security Personnel

1. Provide sufficient security personnel to accomplish the work outlined in these specifications. The Engineer shall have the right to approve and reject the security personnel assigned to the project site at any time during Contractor activities.

2. The Contractor shall ensure that all security personnel shall have received training as specified in Section 01030 and the Site Health and Safety Plan.

3. The Contractor shall conduct coordination visits as needed with local law enforcement and emergency service officials (i.e., state police, emergency medical corps units, fire departments, and utility emergency teams) to map out contingency plans for emergency situations.

1.5 SUBMITTALS

A. Submit one (1) original and two (2) copies of the current list of accredited persons and subcontractors permitted on the project site to the Engineer on request.

B. Submit one (1) original and two (2) copies of the daily personnel visitor and vehicle logs to the Engineer weekly upon request.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01540

SECTION 01560
ENVIRONMENTAL PROTECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall perform all Work in such a manner as to minimize the pollution of air, water or land during, and as the result of, construction operations under this Contract. For the purpose of these Specifications, environmental pollution is defined as the presence of chemical, physical or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and recreational purposes. The requirements of this Section are intended to apply to pollutants, which are generated during the construction process. Pollution from materials at the Site, contacted during construction, must also be minimized.

1.2 RELATED SECTIONS

A. Section 01020 - Special Project Procedures

B. Section 01030 - Contractor Safety and Health

C. Section 02110 – Site Clearing

D. Section 02200 – Excavation and Backfill

E. Section 02270 – Construction Erosion and Sediment Control

1.3 SUBMITTALS

A. The Contractor shall develop and submit a Dust Control Plan to the Engineer for approval. The plan shall detail equipment, materials, activities and contingency actions for controlling dust in accordance with this section and Section 01030 – Contractor Safety and Health.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 PROTECTION OF LAND AREAS

A. It is intended that the land resources within the project boundaries and outside the limits of permanent work performed under the Contract be preserved in their present condition. The Contractor shall confine his construction activities to areas defined by the Drawings and these Specifications.

3.2 PROTECTION OF TREES AND SHRUBS

A. In areas adjacent to and outside the contract limits, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without special authority. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, the Contractor shall first adequately wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event, be responsible for any damage resulting from such use.

B. Where, in the opinion of the Engineer, trees may possibly have been defaced, bruised, injured, or otherwise damaged by the Contractor's equipment or by his dumping, or other operation, the Contractor shall protect adequately such trees to the drip line. Monuments and markers shall be protected by placing boards, planks, or poles around them before beginning operations near them.

C. Any trees or other landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to a condition that will appear natural and not detract from the appearance of the Project ~~at~~ the Contractor's expense. The Contractor shall choose a method of restoration, and shall either treat and heal or remove, dispose, and replace damaged trees, with approval from the Engineer.

D. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than 1-inch in diameter, shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes shall not be permitted. Where tree climbing is necessary, the use of climbing spurs shall not be permitted. Climbing ropes shall be employed where their use is deemed necessary for safety. Trees that are to remain, whether within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving, in the opinion of the Engineer, shall be immediately removed and replaced with a nursery-grown tree of the same species and size. Contractor shall take reasonable steps to insure growth.

3.3 PROTECTION OF WATER RESOURCES

A. The Contractor shall not unnecessarily pollute streams or other water resources, such as Fields Brook or the DS Tributary. The Contractor shall assure the proper disposal of fuels, oils, slurry mixes, agricultural chemicals or other potentially harmful construction related materials. It is the Contractor's responsibility to investigate and comply with all applicable federal, state, county and municipal laws concerning pollution of rivers, streams or other water resources. All work shall be performed in such a manner that objectionable conditions at or adjacent to the Project area are minimized.

B. Water used on-site, shall not be allowed to enter a stream or other water resource. If any material is dumped in unauthorized areas, the Contractor shall remove the material and restore the area to the condition of the surrounding undisturbed area. If necessary, contaminated ground shall be excavated, disposed of and replaced with suitable fill material compacted and finished with vegetative soil at the Contractor's expense.

3.4 STORAGE FACILITIES

A. The Contractor shall use environmentally suitable stockpiling locations for the purpose of storing materials, equipment and suitable backfill material. No material shall be stockpiled on-site, except with the specific approval of the Engineer.

B. The Contractor shall use straw bale sediment barriers and erect temporary fencing or other barriers to mark the boundary of the stockpile areas. Where fill is to be stored in excess of 14 days, the Contractor shall employ a suitable means of protecting excavated material from wind and water erosion. Erosion control methods may include one or more of the following: mulching, sprinkling with water, snow fencing, hay baling, stone covering, plastic sheeting, erosion blankets, silt fence and temporary seeding. Sediment and Erosion Controls shall be implemented in accordance with Section 02270 of this Specification.

C. At the completion of use, restore storage and stockpile locations to the original conditions prior to construction as documented in the Pre-Construction Survey or to conditions specified. Restoration shall commence as soon as the locations are no longer needed for storage or stockpiling purposes.

D. Proposed erosion control measures shall be submitted by the Contractor to the Engineer for review and comment before the Pre-Construction Conference.

3.5 DUST CONTROL

The Contractor shall provide all material, equipment, and labor for monitoring and controlling dust levels. Monitoring and controlling dust shall be performed in accordance with are approved Dust Control Plan and the Contractor's Health and Safety Plans. At a minimum, the following criteria will be adhered to:

A. Water sprinkling methods shall be used to control dust. Chemical dust suppressants shall not be permitted.

B. Fugitive dust suppression techniques shall be employed during all site activities, which may generate fugitive dust.

C. Particulate monitoring must be employed during the handling of contaminated soil and when activities on site may generate fugitive dust from exposed waste or contaminated soil. Such activities shall also include excavation, grading of soil, or placement of clean fill over contaminated soil.

D. Particulate monitoring shall be performed using real-time particulate/aerosol monitor and will monitor particulate matter less than 10 microns in diameter.

E. Appropriate quality control measures shall be employed, including periodic instrument calibration, operator training, daily instrument performance checks, and record keeping.

F. Minimum action levels for dust are discussed in Section 01030 – Contractor Safety and Health.

G. The following techniques can be employed to control the generation and migration of dust:

- Applying water on haul roads
- Wetting equipment and excavation faces
- Spraying water on buckets during excavation and dumping
- Hauling materials in properly covered or watertight containers
- Restricting vehicle speeds to 10 mph or as appropriate
- Covering excavated areas and material after excavation activity ceases
- Reducing the excavation size and/or number of excavations

H. If dust suppression techniques do not lower particulates to an acceptable (action) level, work must be suspended until appropriate corrective measures to remedy the situation are approved by the Engineer and implemented.

3.6 NOISE CONTROL

A. The Contractor shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound levels in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the work.

3.7 ODOR CONTROL

A. The Contractor shall take reasonable measures to minimize odor emitted from handling of the excavated materials. Preventative measures may include the application of a 6-inch soil cover or other acceptable material following the Engineer's approval. All materials which have been disturbed during the course of construction activities shall be covered at the end of each workday using measures approved by the Engineer and maintained subsequently.

3.8 EROSION CONTROL

A. To control erosion, no materials shall be left uncovered for extended periods (and covered at the end of each workday). Preventive measures may include the application of a nominal soil cover. Temporary control measures shall be provided and maintained until no longer necessary. The areas of bare soil exposed at any one time by construction operations should be held to a minimum. In no case shall any drainage route (D.S. Tributary or Fields Brook) be adversely impacted by erosion of soil from the construction area. Erosion control shall be conducted in accordance with Section 02270 and the Drawings.

3.9 HAULING MATERIAL ON STREETS

A. When it is necessary to haul material over streets or pavements, the Contractor shall provide suitable vehicles so as to reduce deposits on the streets or pavements. The Contractor is responsible for insuring that vehicles leaving the Site are clean of dirt and debris. In all cases where any materials are dripped from the vehicles, the Contractor shall clean up the same to keep the streets and pavements free from dirt, mud, stone, or other hauled material. The Contractor is responsible for obtaining all state, county, and local permits to allow transport of any and all materials or equipment on public roadways.

B. The Contractor is responsible for repair of damage to public and private roadways that result from the transport of material to the Site.

3.10 BURNING

A. No burning of tree stumps, discarded construction lumber, or other materials shall be permitted on-site.

3.11 TRASH AND DEBRIS DISPOSAL

A. Except as specifically noted in the Contract Documents, all debris/waste generated as a result of construction operations, shall be removed from the site and disposed of off-site.

B. Contractor must maintain general cleanup practices.

3.12 CORRECTIVE ACTION

A. The Contractor shall, upon receipt of notice in writing from the Engineer, of any noncompliance with the foregoing provisions, take immediate corrective action as specified in the Contract Documents at no additional cost to the Owner.

3.13 POST-CONSTRUCTION CLEANUP/REMOVAL

A. The Contractor shall, unless otherwise instructed in writing by the Engineer, cleanup and remove all temporary construction facilities, work areas, stockpiles of excess materials, and other vestiges of construction prior to final acceptance of the work. The disturbed areas shall be graded and filled and the entire area seeded. Any off-site damage attributable to the Contractor's performance of work shall be repaired at no additional cost to the Owner.

END OF SECTION 01560

SECTION 01590
FIELD OFFICES AND TEMPORARY FACILITIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnishing and maintaining of field offices and storage sheds.

1.2 RELATED SECTIONS

A. Section 01030 - Contractor Safety and Health

B. Section 01510 - Temporary Utilities

1.3 EXISTING FACILITIES

A. There are no existing office facilities at the site for contractor use during construction. There are areas for storage of equipment and materials. These areas will be designated during the pre-construction meeting.

B. Electrical power supply is available, but will have to be extended to equipment and contractor offices.

C. The Owner will pay for monthly service fees for electricity and will also provide potable and non-potable water for the Contractor's use.

PART 2 - PRODUCTS

2.1 GENERAL

A. Field offices and equipment to be used on-site by the Contractor shall be adequate for purposes for which intended and must meet applicable codes and regulations.

2.2 CONSTRUCTION

A. Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed, with steps and landings at each entrance door. Steps shall meet OSHA Standards.

B. Thermal resistance of floors, walls, and ceilings shall be as appropriate for occupancy and storage requirements.

C. Interior office materials shall consist of sheet-type materials for walls and ceilings, pre-finished or painted and resilient floors and bases.

D. Lighting for offices shall produce a minimum illumination of 50 ft-candles at desk-top height. Exterior lighting shall be required at entrance doors. Lighting in storage buildings shall be at least the minimum required for safe operations.

E. The Contractor shall provide an appropriate type fire extinguisher at each office and each storage area.

F. Interior materials in storage areas shall be as required to provide specified conditions for storage of products.

G. The Contractor shall provide one (1) 10 inch outdoor weather thermometer.

2.3 ENVIRONMENTAL CONTROL

A. Heating, cooling, and ventilation for offices shall consist of automatic equipment to maintain ambient inside temperatures of 76 degrees F. when cooling, and 68 degrees F. when heating.

2.4 CONTRACTOR OFFICE AND FACILITIES

A. Contractor shall determine size, furnishings, equipment, and facilities for his own use.

2.5 EMPLOYEE SHELTERS

A. Contractor shall provide area(s) where employees can eat, drink and relax.

B. Personnel will be required to remove their contaminated clothing and to wash their hands before entering the lunch or break area. (Refer to Health and Safety Plan).

C. Heating and/or ventilation for storage buildings shall be as needed to maintain products in accordance with the Contract Documents.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to installation of temporary offices, other buildings, and sheds, the Contractor shall confirm his selected location(s) with the Engineer.

B. Approved locations for temporary structures shall be filled, compacted, and graded to provide drainage away from buildings.

3.2 INSTALLATION

A. The Contractor shall install office buildings and other buildings in accordance with local codes and ready for occupancy 15 days before the start of work activities.

B. At a minimum (and subject to local codes), trailers shall be placed on blocks, leveled and secured with tie-down straps.

3.3 MAINTENANCE AND CLEANING

A. Contractor shall provide daily janitorial services for temporary structures, access and work areas. Janitorial personnel must be health and safety briefed as appropriate.

B. The Contractor shall maintain approach walks free of mud, water, and snow.

3.4 REMOVAL

A. At completion of Work, the Contractor shall remove buildings, foundations, utility services, and debris, as well as, restore areas to condition acceptable to the Owner/Engineer.

END OF SECTION 01590

SECTION 01600
MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Transportation, handling, storage, and protection of materials and equipment.

1.2 RELATED SECTIONS

A. Section 01510 – Temporary Utilities

B. Section 01590 – Field Offices and Temporary Facilities

C. Division 2 – Site Work

D. Division 3 - Concrete

1.3 PRODUCTS

A. Products: New material, machinery, components, equipment, fixtures, and systems for performing the work. Does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Work. Products may also include existing materials or components required for reuse.

B. The Contractor may provide interchangeable components of the same manufacturer, for similar components with approval of the Engineer.

1.4 TRANSPORTATION AND HANDLING

A. The Contractor shall transport and handle products in accordance with manufacturer's instructions.

B. The Contractor shall promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

C. The Contractor shall provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.5 STORAGE AND PROTECTION

A. The Contractor shall store and protect products in accordance with manufacturer's instruction, with seals and labels intact and legible. Sensitive products shall be stored in weather-tight, climate controlled enclosures.

B. Fabricated products stored outside shall be stored placed on sloped supports, above ground.

C. The Contractor shall provide off-site storage and protection when site does not permit on-site storage or protection.

D. The Contractor shall cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

E. The Contractor shall store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

F. The Contractor shall provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

G. The Contractor shall arrange storage of products to permit access for inspection. Products shall be periodically inspected to assure products are undamaged and are maintained under specified conditions.

H. The Contractor is responsible to replace all materials damaged due to improper storage and handling at Contractor's sole expense. Under no circumstances shall damaged materials be installed.

1.6 PRODUCT OPTIONS

A. Products specified by reference standards or by description only: Any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

D. Substitutions for "or equal" products shall be as specified in the Contract Documents and the Instruction to Bidders. In general, any substitution shall required the written approval of the Engineer.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01600

SECTION 01700
WORK CLOSEOUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Comply with requirements stated in Contract Documents and in specifications for administrative procedures in closing out the Work.

B. Perform final site cleanup and decontamination of equipment and materials.

C. Disconnect and remove temporary utilities and facilities.

1.2 RELATED SECTIONS

A. Section 01030 Contractor Safety and Health

B. Section 01020 Special Project Procedures

C. Section 01510 Temporary Utilities

D. Section 01710 Project Record Documents

1.3 PRE-FINAL (PRE-CERTIFICATION) INSPECTION

A. When the Contractor considers the Work substantially complete, he shall submit to the Engineer for review and comment:

1. A written notice that the work, or designated portion thereof, is substantially complete.
2. Draft project record documents required by Section 01710 and all items required by the Specifications to be submitted at completion of construction.
3. A list of items to be completed or corrected.

B. Within a reasonable time after receipt of such notice, the Engineer, the Owner and agencies with a jurisdictional interest shall make an inspection to determine the status of completion. The purpose of the inspection will be to determine if all aspects of the plans and specifications have been implemented at the Site, and that the remedy is operational and functional.

C. Should the Engineer determine that the work is not substantially complete:

1. The Engineer will promptly notify the Contractor in writing with a punchlist which details the outstanding items requiring completion or correction prior to acceptance of work.
2. The Contractor shall remedy the deficiencies in the work, and send a second written notice of substantial completion to the Engineer.
3. The Engineer shall reinspect the work.

D. When the Engineer finds that the work is substantially complete, he shall:

1. Prepare and deliver to the Contractor a tentative Certificate of Substantial Completion, with a tentative list of items to be completed or corrected before final payment.

E. When the Engineer considers the work substantially complete, he shall:

1. Execute and deliver to the Contractor a definite Certificate of Substantial Completion with a revised tentative list of items to be completed or corrected.

1.4 FINAL INSPECTION

A. When the Contractor considers the work complete, he shall submit written certification that:

1. Contract Documents have been reviewed.
2. Work has been inspected for compliance with Contract Documents.
3. Work has been completed in accordance with Contract Documents.
4. Cleanup has been satisfactorily verified and is complete.
5. Work is completed and ready for final inspection.

B. The Engineer shall make an inspection to verify the status of completion with reasonable promptness after receipt of such certification. All items indicated on the punchlist shall be reinspected and all tests that were originally unsatisfactory shall be conducted again.

C. Should the Engineer consider that the work is incomplete or defective:

1. The Engineer shall promptly notify the Contractor in writing. A final punchlist shall be developed for any outstanding deficiencies requiring correction.
2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to the engineer that the work is complete.
3. The Engineer shall reinspect the work.

D. When the Engineer finds that the work is acceptable under the Contract Documents, he shall request the Contractor to make closeout submittals.

1.5 REINSPECTION FEES

A. Should the Engineer perform more than one reinspection due to failure of the work to comply with the claims of status of completion made by the Contractor:

1. The Owner shall deduct the amount of all costs associated with reinspections from the final payment to the Contractor.

1.6 CONTRACTOR'S CLOSEOUT SUBMITTALS TO ENGINEER

A. The Contractor shall submit the final Record Documentation including record and supplemental record drawings in accordance with Section 01710 – Project Record Documents. Final payments and project close out shall not be made until this documentation is submitted by the Contractor and approved by the Engineer.

B. The Contractor shall prepare a written statement which certifies that all items contained in the Contract Documents have been completed and that the final cover system is operational and functional.

C. The Contractor shall submit evidence of Payment and Release of Liens.

D. The Contractor shall submit an application for Final Payment (retainage).

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 DECONTAMINATION

A. Without exception, all recoverable Contractor owned equipment and materials shall be decontaminated by the Contractor prior to final removal from the Site.

B. Decontamination shall take place within the equipment and materials decontamination area designated in these specifications and the Contractor Health and Safety Plan. Decontamination shall consist of de-greasing (if required) followed by high pressure, hot water cleaning supplemented by detergents as appropriate. Special attention shall be paid to removal of material on and within the tracks and sprockets of crawler equipment, and the tires and axles of trucks and rubber mounted equipment.

3.2 FINAL APPROVAL

A. Prior to removal from Site, all decontaminated equipment and materials shall be inspected and approved by the Engineer.

B. Certification of decontamination shall be attested to by the Site Health and Safety Officer.

C. A copy of each decontamination certificate shall be provided to the Engineer, and the Contractor's Site Health and Safety Officer.

3.3 TEMPORARY UTILITIES

A. Temporary utilities including telephone and electricity shall be shut off or disconnected and removed in accordance with the supplying utilities' requirements.

3.4 EQUIPMENT AND MATERIALS DECONTAMINATION FACILITY

A. Upon completion of equipment and materials decontamination, the Owner's equipment and material decontamination facility shall be thoroughly washed down and sediments removed and disposed off-site by the Contractor. The area shall be returned to a condition comparable to preconstruction conditions and approved by the Engineer.

END OF SECTION 01700

SECTION 01710
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Provisions for maintaining Record Documents.

B. Requirements for Record Drawings: The Contractor shall provide both record drawings (redline markups of the Contract Drawings) and supplemental record drawings (newly created drawings).

1.2 RELATED SECTIONS

A. Section 01030 Contractor Safety and Health

B. Section 01050 Survey

C. Section 01380 Construction Photographs

D. Section 01700 Work Closeout

1.3 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. The Contractor shall maintain at the site for the Engineer/Owner one record copy of:

1. Construction Drawings
2. Record and Supplemental Drawings (Continuously updated and accurate)
3. Specifications
4. Addenda
5. Change Orders and other Modifications to the Contract
6. Field Orders or written instructions
7. Approved Working Drawings and Samples
8. Field Test records
9. Laboratory analyses
10. Construction photographs and negatives
11. Quality Assurance Reports and documentation
12. Medical surveillance records
13. Daily reports
14. Meeting minutes
15. Correspondence files

16. Survey notes

B. The Contractor shall store documents and samples in Contractor's field office apart from documents used for construction.

1. Provide files and racks for storage of documents.
2. Provide locked cabinet or secure storage space for storage of samples.

C. The Contractor shall file documents and samples in accordance with CSI format.

D. The Contractor shall maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.

E. The Contractor shall make documents and samples available at all times for inspection by the Engineer.

F. As a prerequisite for monthly progress payments, the Contractor is to exhibit the currently updated "record documents" for review and comment by the Engineer.

1.4 RECORDING

A. The Contractor shall label each document "PROJECT RECORD" in neat large printed letters.

B. The Contractor shall record information concurrently with construction progress. No work shall be concealed until required information is recorded.

1.5 SUBMITTALS

A. As part of Substantial Completion, Contractor shall deliver one (1) set of neatly marked Record Documents to the Engineer.

B. The Contractor shall deliver all submittals required by the specifications to the Engineer at completion of construction.

1.6 RECORD DRAWINGS

A. The Contractor shall clearly and neatly mark up in red ink one set of paper prints to show the record conditions. These record marked prints shall be kept current and available on the jobsite at all times. All changes from the contract plans which are made in the work, or additional information which might be uncovered in the course of construction shall be accurately and neatly recorded as they occur by means of details and notes. The record marked prints shall be jointly inspected for accuracy and completeness by the Engineer and a responsible representative of the Contractor prior to submission of each monthly pay estimate. The drawings shall show the following information, but not be limited thereto:

1. The location and description of any utility lines, below-grade permanent structures or other installations of any kind or description known to exist within the construction area. The location includes dimensions to permanent features.
2. The location and dimensions of any changes within the design and any project components.
3. Correct grade or alignment of roads, structures, utilities, or project component if any changes were made from contract plans.
4. Correct elevations if changes were made in site grading (provide notes referring to Supplemental Record Drawings where applicable).
5. Changes in details of design or additional information obtained from working drawings specified.
6. The topography and grades of all drainage installed or affected as a part of the project construction (provide notes referring to Supplemental Record Drawings where applicable).
7. All changes or modifications which result from the final inspection.
8. Where contract drawings or specifications allow options, only the option selected for construction shall be shown on the record prints.

1.7 SUPPLEMENTAL RECORD DRAWINGS

A. The Contractor shall prepare and submit supplemental record drawings of the work completed as described in the technical specifications.

B. Record and Supplemental Record drawings shall be stamped and signed by a land surveyor licensed in the State of Ohio.

C. Each record drawing shall be prepared on a 24" by 36" sheet and shall locate all work included in the Contract.

D. All locations shall be referenced to the horizontal coordinate system. The grid coordinate system shall be shown on all record drawings. Elevations shall be referenced to the vertical control established for the project.

E. An electric file of each record drawing in AutoCad Release 14 shall be provided to the owner.

1.8 DRAWING PREPARATION

A. Two (2) copies of the final record (redline) drawings will be provided by the Contractor after final approval of the drawings by the Engineer.

B. After final acceptance of the Supplemental Record Drawings, the Contractor shall provide one set of Mylars (stamped by the licensed surveyor), and six sets of blue prints.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION 01710

DIVISION 2
Site Work

SECTION 02110
SITE CLEARING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Furnish all equipment and materials, and perform all labor required to transport, place, and finish for work as shown on the drawings and as specified herein.

B. Clear and grub vegetation from the project site and adjacent areas designated on Specification Drawings C-5A and C-5B, and as determined in the field. Dispose of vegetation on-site.

C. Strip and stockpile cleared and grubbed topsoil in approved areas, for subsequent use to revegetate the site.

1.2 RELATED SECTIONS

A. Division 1, General Requirements.

B. Section 02130 - Contaminated Materials Handling

C. Section 02200 - Excavation and Backfill

1.3 QUALITY ASSURANCE

A. The Contractor shall comply with local, state, and Federal laws and code requirements governing the hauling and disposal of trees, shrubs, stumps, roots, rubbish, debris, and other matter.

1.4 JOB CONDITIONS

A. Streets, roads, adjacent property and other works and structures shall be protected during site clearing operations. Damaged facilities caused by the Contractor's operations shall be returned to their original conditions by repair or replacement, to the satisfaction to the Owner.

B. Trees, shrubs, and grassed areas, which are to remain undisturbed shall be protected by fences, barricades, wrapping or other methods as shown, specified, or approved by the Engineer. Trees and any other plant growth

shall not be removed or disturbed unless shown, specified, or directed by the Engineer.

1.5 GUARANTEE:

A. The Contractor's operations shall not permanently damage trees, shrubs, turf or plants designated to remain, or other adjacent work or facilities. If damage resulting from the Contractor's operations remains after acceptance of the Work, the Contractor shall replace damaged items to the satisfaction of the Engineer or Owner.

1.6 SUBMITTALS:

A. The procedures proposed for the accomplishment of clearing work and grubbing shall be submitted for approval. The procedure shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 CLEARING:

A. The limits of disturbance shall be provided to the Contractor at the preconstruction conference (pre-bid meeting). Damage outside these limits caused by the Contractor's operations shall be corrected by the Contractor at no cost to the Owner. The limits of clearing and grubbing shall be as shown on the Drawings and as determined in the field by the Engineer.

B. Trees, stumps, brush, exposed roots, and other vegetation in areas to be cleared, shall be cut off flush with the existing ground surface, and grubbed to the depth of cut or to the depth of stripping, whichever is deeper.

C. The Contractor shall shred all cleared trees, shrubs, roots, brush, and other vegetation and stockpile on-site for revegetation in an area designated by the Engineer..

3.2 STRIPPING AND STOCKPILING TOPSOIL

A. The Contractor shall clearly stake out the limits of the work to the satisfaction of the Engineer, prior to the start of stripping operations.

B. The limits of stripping, both horizontally and vertically, are subject to the approval of the Engineer prior to, and at the completion of, stripping.

C. The Contractor shall be responsible for performing all stripping and stockpiling of topsoil and vegetation in accordance with the directions of the Engineer. No stripping shall be started without the approval of the Engineer.

D. Vegetation shall be stripped and stockpiled in approved areas prior to stripping topsoil. Topsoil shall be stripped to a depth where satisfactory topsoil is encountered and in such a manner as to prevent intermingling with the underlying subsoil or other objectionable material.

E. The Contractor shall stockpile topsoil in the approved areas or where otherwise directed by the Engineer.

F. All topsoil stockpiles shall be temporarily vegetated and/or mulched. The Contractor shall be responsible for removing any accumulations of sediment resulting from runoff from the stockpiles, at any time during construction and as directed by the Engineer. The Contractor shall be responsible for any damages, loss of soil fines, and other costs as the result of not properly controlling the stockpile area. Stripped topsoil in excess of the minimum quantity required for future use in the work shall remain property of the Owner and remain in stockpiles, or shall be placed and spread on site, as directed by the Engineer.

END OF SECTION 02110

SECTION 02130
CONTAMINATED MATERIALS HANDLING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The work in this section consists of excavation, stockpiling and disposal of materials designated for disposal. This includes the catalyst pile, excavated soils from the slurry wall that can not be re-used, excavated soils from the groundwater collection trench installation that can not be re-used, soils and sediments excavated adjacent to the DS Tributary, and project-generated contaminated materials.

1.2 RELATED SECTIONS

A. Section 02168 – Soil-Bentonite Slurry Wall

B. Section 02170 - Cofferdams

C. Section 02200 – Excavation and Backfill

D. Section 02221 – Groundwater Collection Trenches

E. Section 02271 - Erosion Control

1.3 PROTECTION

A. Excavations shall be protected as specified in these specifications and in OSHA 29 CFR 1926 Subpart P.

B. All necessary precautions shall be taken to protect workers from exposure to contaminated materials.

C. Surface water run-on shall be directed away from open excavations.

D. Contractor shall make every effort to minimize discharge of surface or ground water runoff that has contacted contaminated materials. The Contractor shall devise a plan to minimize runoff discharge during contaminated materials handling compatible with Section 02271 - Erosion Control.

1.4 SUBMITTALS

A. Submit a Contaminated Materials Handling Plan. At a minimum, this plan shall provide the equipment to be used, transport routes to the SOU Landfill, and proposed methods for minimizing run-on waters and minimizing exposure of contaminated materials.

B. Materials Samples: Submit adequate and representative samples of the backfill material that is to be used for backfill to the Engineer for pre-construction tests.

C. Licenses: Contractor will provide copies of transporter's licenses to transport special or hazardous or special waste in the State of Ohio.

PART 2 – PRODUCTS

A. General fill material shall meet the following requirements:

Property	**Standard**	**Test Value**
Plasticity Index	ASTM D4318	30 (max)
Gradation	ASTM D4318	50 (max)

Sieve Size	**% Passing**
2-inch	100
#4	80 to 100
#200	10 to 100

PART 3 - EXECUTION

3.1 CONTAMINATED MATERIAL EXCAVATION AND STOCK PILING

A. Excavation of contaminated materials shall be performed in accordance with Section 02200 – Excavation and Backfill. Contaminated materials that are designated for disposal shall be placed in the SOU Landfill.

B. The contaminated materials that require disposal will be temporarily stored on-site in lined, covered, roll-off containers. These containers will be staged in an area designated by the owner.

C. As an alternative, or in addition to, storage in roll-off containers, contaminated materials may be loaded directly into lined dump trailer equipped with covers, and transported directly to the SOU Landfill.

D. The Contractor shall excavate and stockpile contaminated materials by means of approved procedures and equipment. Normal earthwork excavation shall be used wherever possible.

E. The Contractor shall employ construction techniques and equipment that prevents any adverse environmental impact and which complies with the contractor Health and Safety Plan. In the event the Engineer determines that the Contractor is employing inappropriate procedures or equipment, the Engineer shall issue a written order establishing the limits of acceptable procedures and noting acceptable equipment. The Contractor shall revise procedures or use other approved equipment at Contractor's sole expenses.

3.2 CONTAMINATED SOIL DISPOSAL

A. All excavated contaminated materials designated for disposal will be transported by designated haul route to the SOU Landfill for disposal.

B. Contractor is responsible for complying with all local, state, and federal regulations applicable to the transport of contaminated or special waste.

C. Contractor is responsible for obtaining all required permits or licenses, or sub-contracting a licensed transporter, to transport contaminated materials on public roadways.

D. Contractor shall place materials in the SOU Landfill at the direction of the of the SOU Contractor.

E. Soils will be transported directly to the SOU Landfill and will not be co-mingled with wastes from any other off-site locations.

3.3 CONTAMINATED WATER RECOVERY AND HANDLING

A. All groundwater recovered by the temporary recovery sump in the DS Tributary shall be considered contaminated. All surface water runoff into this area during work activities shall also be considered contaminated.

B. Contractor shall route all contaminated water via closed conduit to the Detrex water treatment system for treatment. Pump Station No. 2 is shown in specification drawings attached.

C. Contractor shall provide all necessary safety personnel and equipment, including protective gear, emergency equipment, monitoring equipment, and decontamination facilities required for handling the contaminated water in accordance with Contractor's approved Health and Safety Plan.

3.4 HEALTH AND SAFETY CONSIDERATIONS

A. Contractor shall perform all handling of excavation spoils in strict accordance with the Contractor's approved Health and Safety Plan and Section 01030.

B. Contractor shall decontaminate all equipment that was used to handle contaminated soil before leaving the site in accordance with the Contractor's approved Health and Safety Plan.

C. Contractor shall provide all necessary safety personnel and equipment, including protective gear, emergency equipment, monitoring equipment, and decontamination facilities required for handling the contaminated soil in accordance with the Contractor's approved Health and Safety Plan.

END OF SECTION 02130

SECTION 02168
VERTICAL BARRIER WALL

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. The work under this Section consists of furnishing all labor, equipment, materials and supervision for constructing a soil-bentonite vertical barrier wall at the Detrex Corporation facility in Ashtabula, Ohio and on the adjacent property to the north, which is owned by RMI Sodium.

B. A portion of the vertical barrier wall passes under an active rail spur that will be temporarily decommissioned. Contractor will take all reasonable measures to minimize the length of time that the rail spur is out-of-service, including working 24 hours per day, if necessary.

C. The Contractor shall have a minimum of 5 years of experience with work comparable to the work shown and specified, employing labor and supervisory personnel experienced in this type of work. The Contractor shall perform all work necessary for the complete construction of a soil-bentonite vertical barrier wall by the slurry trench method or using one-pass continuous trenching equipment, as shown on the Contract Drawings or inferable therefrom, in accordance with the requirements of the Contract Documents. The work shall include, but not be limited to the following items:

1. Preparation of a working pad surface.
2. Excavation of the vertical barrier wall in sequential panels using slurry trench or one-pass continuous trenching techniques.
3. Circulation and maintenance of bentonite slurry, if slurry trench installation techniques are used.
4. Placing soil-bentonite backfill in the slurry-filled panels as shown on the drawings.
5. Restoration of the work area.

D. In the completed project, the vertical barrier wall is intended as a permanent groundwater cut off. The vertical barrier wall shall be watertight. The term "watertight" is used here to indicate the following: 1) performance criteria

and 2) wall material permeability does not exceed $1x10^{-7}$ cm/sec. If these conditions are not met, the Contractor must propose and implement measures to correct deficient conditions.

E. The vertical barrier wall shall be founded in the naturally occurring clay till layer underlying the shallow lacustrine deposits. The depth of the vertical barrier wall has been estimated from alignment borings and some variation in the depth is to be anticipated. In general, the depth is 25 feet from ground surface. The vertical barrier wall shall penetrate the underlying clay till layer a minimum of 2 feet.

1.2 RELATED SECTIONS

A. Section 02110 Site Clearing

B. Section 02130 Contaminated Materials Handling

C. Section 02170 Cofferdams

D. Section 02200 Excavation and Backfill

E. Section 02450 Railroad Work

F. Section 02270 Sediment and Erosion Control

1.3 DEFINITIONS

A. A vertical barrier wall as referred to herein, is a wall of the minimum dimensions shown on the Drawings, excavated through the existing soils into the clay till layer by the slurry trench method of excavation or by one-pass continuous trenching excavation techniques, and backfilled with a soil-bentonite mixture to form a permanent groundwater cut-off device. The wall must be resistant to cracking and erosion.

B. The slurry trench method of excavation consists of excavating a trench in the existing soils while at the same time keeping the trench filled with bentonite-water slurry. The basic purposes of the slurry are to maintain the stability of the walls of the trench during construction and to form a thin, low permeability bentonite layer along the sidewalls and base of the vertical barrier trench.

C. Slurry is a stable, colloidal, thixotropic suspension of powdered bentonite in water.

D. One-pass continuous trenching refers to excavation of the vertical barrier trench and placement of the design mix backfill within the trench in a single, uninterrupted pass. This excavation technique would not rely on slurry to maintain the trench stability. The soil-bentonite backfill mix is equivalent to that for a slurry trench.

E. Bentonite is a natural clay whose principal mineral constituent is sodium montmorillonite.

F. Surface water is all water that enters the work area above the ground surface from either natural or artificial sources.

G. Groundwater denotes all water below the existing ground surface within the work area.

H. The working pad is the surface on which the equipment shall operate to construct the wall. The elevation of this surface along the alignment of the trench shall be such that it does not cause slurry in any part of the open trench to be more than 2 feet below the top of the trench or less than 5 feet above groundwater level, unless major slurry loss occurs.

I. Soil-bentonite is a low strength mixture of soil and bentonite-water slurry. The soil used to make the backfill may be selected from uncontaminated excavation spoils or may be imported.

1.4 REFERENCES

A. Material requirements and tests performed on the specified materials shall conform to the following standards. In the event of a conflict between this Specification and the referenced standards, this Specification shall govern.

1. American Petroleum Institute (API)
   a. API Specification 13A: "Specification for Oil Well Drilling Fluid Materials"
   b. API Recommended Practice 13B: "Standard Procedure for Testing Drilling Fluids"
2. American Society for Testing and Materials (ASTM)
   a. ASTM D-4380 - "Test Method for Density of Bentonite Slurries."
   b. ASTM C-143 - "Test for Slump of Portland Cement Concrete"

c. ASTM D-5084 - "Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter."

3. U.S. Army Corps of Engineers, EM-1110-1-163, *Checklist for Design of Vertical Barriers for Hazardous Waste Sites*, June 30, 1996.

1.5 SUBMITTALS

A. The Contractor shall submit, for review and acceptance by the Engineer, the following items ten (10) days prior to starting the work:

1. Detailed Construction Schedule.
   a. The Contractor shall submit a detailed critical path schedule which includes mobilization, work platform preparation, vertical barrier wall construction, and anticipated contingencies to assure that the project schedule is met. The submittal shall indicate production rates and shift schedules needed to meet the project requirements.
2. The Contractor's proposed construction methodology including:
   a. Proposed vertical barrier wall alignment location verification;
   b. Proposed method of sequencing construction with other work;
   c. Proposed remedial measures to be implemented in the event of excessive slurry loss, if slurry trenching excavation techniques are proposed;
   d. Proposed excavation and backfill placement procedures, if one-pass continuous trenching techniques are proposed;
   e. Proposed methods to handle trench collapse prior to the completion of backfilling;
   f. Proposed procedures to stabilize the trench in subsequent trench excavation and backfilling following a collapse event;
   g. Methods of maintaining and measuring panel verticality;
   h. Methods of batching and placing backfill;
   i. Excavation method;
   j. Trench cleaning methods;
   k. Method of confirming bearing material; and
   l. Quality control plan.

3. Revisions (if any) to equipment schedules from those submitted with the qualifications response.

4. Documents and shop drawings as follows:
   a. Backfill mix designs.
   b. Bentonite slurry mix proportions.
   c. Engineering calculations.

5. Materials: Documents certifying the properties of bentonite and other materials. At the Engineer's request, the Contractor shall furnish samples of any other materials in sufficient amount for independent quality control testing.

6. A Detailed Contingency Plan outlining steps to be followed in the event of slurry loss shall be prepared. The plan shall outline steps to be followed if rapid slurry loss is encountered (i.e. a construction emergency action plan).

7. Proposed method of treating excessive slurry loss, (grouting, etc.).

8. Proposed method(s) to prevent bentonite slurry from entering nearby water courses or sewer lines in the event of slurry loss.

1.6 METHOD OF MEASUREMENT

A. The soil-bentonite vertical barrier wall, complete in place, will be measured by the number of square feet of wall installed. Measurement will be made of the final installation. The top of wall elevation for measurement shall be the elevation shown in the Drawings. The bottom of wall elevation for payment will be the as-constructed elevation as measured by and approved by the Engineer.

B. Excess slurry loss will be measured by the number of cubic feet of slurry lost as determined by the Engineer from actual trench measurements. Only that volume of slurry loss resulting from a drop in the slurry surface in the excavation greater than 5 feet in a period of 30 minutes or less, not resulting from the removal of excavated material, will be measured for payment.

PART 2 PRODUCTS

2.1 MATERIALS

A. Bentonite used in preparing the bentonite-water slurry and soil-bentonite backfill mix shall be sodium montmorillonite bentonite. Bentonite shall

meet the latest version of API Standard 13A "Specification for Oil Well Drilling Fluid Materials." The clay mineral additive shall be Wyo-Ben, Inc. SW-101 or approved equal.

B. Water used in preparing the bentonite-water slurry and soil-bentonite backfill shall be clean and free from deleterious amounts of soil, salts, and organic matter such that the resulting slurry has the necessary properties to provide stability of the trench and the cement-bentonite mixture has the desired backfill characteristics. The total dissolved solids shall be less than 500 ppm. The water shall be the ASHCO process water supply that is available at the Detrex Corporation facility or approved equal.

C. Additives such as dispersants, plugging agents, and/or softeners may be added to the water or slurry so as to obtain proper workability of the slurry and efficient use of the bentonite. Additives to the slurry shall be approved by the Engineer prior to use.

D. The backfill material shall be composed of slurry, and silt, clay and sand soil materials, which may be obtained from uncontaminated portions of the trench excavation or other source approved by the Engineer. The backfill gradation will conform to the soil-bentonite backfill mixture that achieved the target laboratory permeability of 5×10^{-8} cm/sec (Attachment D). Soils shall be thoroughly mixed with slurry and, at the time of placement, shall be well-graded with a minimum of 30 percent finer than the No. 200 sieve. The addition of dry bentonite or clay may be required.

2.2 EQUIPMENT

A. Slurry Plant - The Contractor shall provide and operate a slurry plant in an onsite location designated by Detrex. The plant will include a bentonite storage facility, high speed colloidal slurry mixer, and storage ponds or slurry tanks. The ponds or tanks shall have a capacity of at least 1,000 gallons to allow a minimum 8-hour hydration time and to serve as a reservoir in case of rapid slurry loss. The slurry shall be agitated or recirculated in the tanks or ponds.

B. Excavation Equipment - The Contractor shall provide sufficient numbers and types of excavating equipment such as backhoes and/or clamshells to complete each panel to the final depth and to complete the project within the schedule. Equipment shall be special slurry trench or one-pass continuous excavating equipment or combinations of equipment capable of completing vertical barrier wall construction. Air lift pumps and slurry

desanders or other appropriate tools shall be used, as necessary, to clean the trench bottom and/or slurry, as required.

C. Backfill Mixing Plant - The soil-bentonite backfill shall be mixed in a pugmill or equivalent type of equipment approved by the Engineer. Initial placement of backfill in the trench will require a clamshell bucket or tremie pipe.

2.3 UTILITIES

A. Contractor shall be responsible for connection to the ASHCO water supply and routing of water from the connection to the slurry and backfill mixing plants.

B. Contractor shall be responsible for connection to the Detrex Corporation electrical panels or provision of a power supply to obtain the necessary electrical power for the mix plants.

C. Contractor shall be responsible for supplying all other utility components necessary for the operation of the vertical barrier wall installation equipment and batch mixing equipment.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. The vertical barrier wall shall be constructed to the following lines and depths on the alignment shown on the Drawings, unless otherwise authorized by the Engineer.

1. Depth: The vertical barrier wall shall penetrate the clay till layer underlying the lacustrine sediments a minimum of two feet. The assumed wall depths are shown on the Contract Drawings. After examination of the bottom material, the Engineer shall determine the necessity for extending the wall deeper. After the trench excavation reaches the accepted depth, the Engineer and Contractor shall measure and document the actual wall depth.

2. Width: The minimum width of the soil-bentonite vertical barrier wall will be determined by the width of the required excavating equipment, but shall not be less than 24 inches wide at any point along the wall's depth.

3. Alignment: The horizontal alignment shall be as shown in the Contract Drawings.

4. Verticality and Continuity shall be as specified herein.

3.2 BENTONITE-WATER SLURRY

A. The bentonite-water slurry shall be prepared by mixing powdered bentonite (Wyo-Ben, Inc. SW 101 or approved equal) with water in a high-speed colloidal mixer which achieves complete dispersion of the bentonite particles. The bentonite slurry shall be fully hydrated for a minimum of 8 hours after mixing in the colloidal mixer before introduction into the trench. The slurry shall be maintained in holding ponds or tanks and agitated to hold all particles in suspension.

Bentonite slurry shall have the following limiting properties:

Property	Fresh	In Trench
Viscosity	32 to 40 Marsh seconds	32 to 50 Marsh seconds
Density	1.03 to 1.04 g/cm^3 (64.3-64.9 lbs/ft^3)	1.04 to 1.37 g/cm^3 (64.3-85.5 lbs/ft^3)
Bentonite	5 to 6 percent by weight	5 to 6 percent by weight
pH	6.5 to 10	6.5 to 12
Filtrate loss	15-20 ml @ 100 psi	15-30 ml @ 100 psi

The Contractor shall be responsible for maintaining the stability of the trench excavation. Weighting agents may be used to increase the density of the slurry, if necessary to maintain trench stability.

3.3 SOIL-BENTONITE BACKFILL

A. The bentonite slurry and silt, clay and sand soil materials that comprise the backfill material shall be thoroughly mixed in a pugmill or other suitable equipment approved by the Engineer to form a homogeneous mass. The mass shall be free of lumps of clay and pockets of slurry or sand.

B. The consistency of the backfill mix shall be such as to produce a slump cone reading of 4 to 6 inches when measured by the standard method of test for concrete. The slump requirement may be varied subject to approval by the Engineer in order to improve placement operations.

C. Mixing of backfill with slurry in the trench shall not be permitted. The Contractor will demonstrate to the Engineer the suitability of the backfill mix before placement.

D. Soil-bentonite backfill shall have the following limiting properties:

Property	Acceptable Range
Moisture Content	32 to 45 Percent
Density – Total Weight	(109-124 lbs/ft^3)
Density – Dry Weight	(73-97 lbs/ft^3)
Bentonite Content	3 to 4 percent by dry weight
pH	6.5 to 10

3.4 PANEL LAYOUT AND SEQUENCE

A. The vertical barrier wall will be installed as a series of vertical panels that are linked end-to-end without horizontal offset. The thickness of the panel joints shall be increased, as necessary, to eliminate any horizontal offset in adjacent panels.

B. The Contractor shall engage a Professional Surveyor registered in the state of Ohio to lay out primary and secondary panels with a sequential numbering system along the wall alignment. The Contractor shall submit a reproducible drawing to the Engineer showing the panel layout and numbering.

C. The Contractor shall begin the vertical barrier wall installation with the southernmost panel and move progressively northward toward the DS Tributary Contractor may elect to continue northward with panel installation, crossing the rail spur and continuing northward to the northern terminus of the wall. Alternatively, Contractor may halt the northward sequence of panel installation south of the DS Tributary, move to the northern terminus of the wall and begin panel installation southward, and install the final panel beneath the rail spur.

D. The Contractor shall coordinate the vertical barrier wall construction with the Engineer and CSX at the location where the vertical barrier wall passes beneath the rail spur serving Occidental Chemical Corporation. CSX shall be responsible for removal and replacement of railroad tracks and ballast.

3.5 TRENCH EXCAVATION

A. The Contractor shall provide labor and equipment sufficient to operate excavation equipment during routine construction of the wall. Adequate replacement equipment and maintenance and supervisory support shall be provided to minimize equipment downtime and maintain the construction schedule.

B. The Contractor shall be responsible for maintaining a stable suspension of bentonite slurry in the trench sufficient to maintain the stability of the trench walls. Bentonite slurry shall be introduced into the trench when excavation begins. The level of the slurry in the trench shall be maintained no more than two feet below the working pad surface at all times.

Prior to the beginning of trench excavation, the Contractor shall submit a Contingency Plan for steps to be implemented in the event of slurry loss or trench collapse. The Contractor shall be responsible for all costs associated with implementing the plan. The steps which the Contractor shall take in the event of a slurry loss shall, at a minimum, include: 1) increasing slurry viscosity; 2) backfilling trench with stockpiled sand and/or gravel materials and re-excavating; and 3) use of cement/bentonite backfill and re-excavating. The plan shall also indicate steps to be taken to contain lost slurry to prevent stream contamination.

The Contractor shall maintain a stockpile of suitable materials, such as sand and/or gravel as necessary to be used for emergency backfilling in the event of sudden, rapid slurry loss or used as outlined in the Contingency Plan.

C. The Contractor shall maintain panel verticality within three (3) percent over the entire depth of the trench and a maximum deviation of 6 inches. Verticality shall be checked throughout the excavation process using the clamshell pendulum measurement or an alternate approved method of measuring verticality compatible with the Contractor's equipment. The method of measuring verticality shall be discussed in the Technical Proposal and shall be accepted by the Engineer prior to use. After completion of excavation the entire depth shall be checked. Deviation over that specified shall be corrected by special chisel or other excavation tool.

D. The bottom of the trench shall be cleaned using an airlift consisting of 10 inch minimum diameter pipe and a minimum 180 cfm compressor or other approved equipment. Airlifting shall be continued until all loose soil, debris, cobbles and contaminated slurry pockets have been removed. Bottom conditions shall be checked by probing.

To maintain the properties of the slurry in the trench at the required levels and to keep it clean and workable, the slurry in the trench shall be recirculated as required and the excess suspended matter separated by use of stilling ponds, screens, cyclones, or other appropriate equipment as approved by the Engineer.

3.6 BACKFILL PLACEMENT

A. The backfill materials shall be thoroughly mixed with the slurry in a pugmill or other suitable equipment approved by the Engineer to form a homogeneous mass just prior to the backfilling operations. The mass shall be free of lumps of clay and pockets of slurry or sand. Mixing of backfill with slurry in the trench shall not be permitted.

B. If slurry trenching techniques are used, backfill shall be placed in the trench by displacing the bentonite slurry. However, no backfill shall be placed until the trench has been inspected and approved by the Engineer.

1. Initial Placement: The backfill mix shall initially be lowered to the bottom of trench at the start of the trench section and deposited by means of a clamshell bucket or a tremie pipe. The bucket or tremie pipe shall be lowered to the bottom of the trench or top of backfill before opening and discharging backfill. No free-dropping of backfill material directly into the trench or any other methods of construction that will produce segregation of material will be allowed. This procedure shall be followed until the backfill emerges from below the slurry surface and until its natural angle of repose is achieved from the bottom of the trench to the surface.

2. Remaining Backfill: The remaining backfill shall be placed in such a manner that the natural angle of repose of the backfill will be maintained and so that no pockets of slurry are present in the completed vertical barrier. Backfill material must be maintained a minimum of 10 ft and a maximum of 50 ft behind the face of the excavation. The toe of the backfill material that rises to the top of the trench at the terminal end of the trench shall be re-excavated as necessary to remove any entrapped slurry, silts, and sands that may exist. This material shall be replaced with new backfill material.

3. If one-pass continuous trench excavation techniques are used, the backfill shall be emplaced as recommended by the equipment manufacturer.

3.7 CAP INSTALLATION AND SURFACE RESTORATION

A. In order to protect the completed slurry wall backfill from desiccation, a temporary non-compacted soil cover shall be placed over the backfill. The temporary soil cover shall be placed within one day of completion of backfill activities on that panel section.

B. After allowing for settlement (a minimum of one week, except in the vicinity of the DS Tributary and railroad cut), the temporary soil cover shall be removed. This temporary cover soil may be used as fill in other portions of the property.

C. A minimum 1-foot thick compacted clay cap shall be installed over the completed slurry wall. The cap shall extend a minimum of 1 foot beyond the horizontal limits of the slurry wall.

3.8 QUALITY CONTROL

D. The Contractor shall be responsible for quality control testing. The Engineer shall be responsible for the Owner's quality assurance of the backfill mix, trench excavation, and backfill placement. The Contractor shall assist the Engineer in performance of the quality assurance testing.

E. The following items shall be performed by the Contractor's slurry wall specialist with concurrent verification by the Engineer:

5. Monitoring and logging of materials encountered during excavation. The depth of the excavation shall be sounded prior to each verticality control check, at the clay till/lacustrine interface, and at the beginning and end of each shift.

6. The Contractor shall make and record depth soundings every 20 feet, at a minimum, along the trench centerline. Soundings at each location shall consist of the following:

   a. Measurement of the depth to the bottom of the excavation immediately after excavating.

   b. Measurement of depth to the bottom of the excavation immediately before backfilling. Soundings shall be made with a weighted cable with a flat plate or similar device approved by the Engineer.

4. Monitoring of slurry consumption and exceptional slurry loss.

5. Trench verticality and horizontal alignment checks at 20 foot depth intervals throughout the excavation sequence and at the completion of trench excavation.

6. Monitoring correction of any verticality deviations.

Properties of the bentonite slurry during excavation and prior to backfill placement shall be measured by the Contractor. Samples shall be taken in the trench and at the slurry plant. Quality control tests include Marsh Funnel viscosity, mud balance density, sand content, filtrate loss, and pH, as specified by API Recommended Practice 13B: "Standard Procedure for Testing Drilling Fluids.

F. The Contractor shall perform at least one slump cone test for each 25 linear feet of backfilled trench length.

G. A minimum of one set of soundings will be made daily of the depth to surface of the backfill at 20-foot spacings along the trench.

3.9 REMEDIAL MEASURES

A. Should the Contractor be directed by the Engineer to deepen the wall in an area or conduct a grouting program for reasons other than to correct a construction defect, the cost of this work would be reimbursed by the Owner at the unit prices listed in the contract.

3.10 DISPOSAL OF WASTE MATERIALS

A. The Contractor shall legally dispose all excess excavated material and waste slurry either on- or off-site. The Contractor is responsible for obtaining the required permits for hauling and disposal.

B. The Contractor shall dispose all debris, rubbish and other solid waste materials in an approved off-site disposal area.

C. The Contractor shall transport and dispose of all excavated materials from the vicinity of the DS Tributary in accordance with Section 02130. This material is approved for disposal in the SOU Landfill.

END OF SECTION 02168

SECTION 02170
COFFERDAMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The work in this section consists of the temporary damming and dewatering of the DS Tributary, a surface stream, to allow for soil and sediment excavation and the subsequent installation of a slurry wall and groundwater collection trenches.

B. Soils, sediments, surface water and groundwater produced during execution of this work will require handling as potentially hazardous materials and upgraded health and safety measures may be anticipated.

C. The work under this section may be conducted, in part or in whole, with work performed in the DS Tributary as part of the remedial action of the Sediment Operable Unit (SOU) of the Fields Brook Superfund Site.

1.2 RELATED SECTIONS

A. Section 01030 – Contractor Health and Safety

B. Section 02130 – Contaminated Materials Handling

C. Section 02168 – Soil-Bentonite Slurry Wall

D. Section 02200 – Excavation and Backfill

E. Section 02221 – Groundwater Collection Trenches

F. Section 02271 - Erosion Control

1.3 PROTECTION

A. Excavations shall be protected as specified in these specifications and OSHA 29 CFR 1926 Subpart P and Section 23 of EM 385-1-1.

B. All necessary precautions shall be taken to protect workers from exposure to contaminated materials.

C. Surface water run-on shall be directed away from open excavations.

D. Contractor shall make every effort to minimize discharge of surface water runoff that has contacted contaminated materials. The Contractor shall devise a plan to

minimize runoff discharge during contaminated materials handling compatible with Section 02271 - Erosion Control.

1.4 SUBMITTALS

A. Submit a Contaminated Materials Handling Plan (Section 02130). At a minimum, this plan shall provide the equipment to be used, transport routes to the SOU Landfill, routing of recovered groundwater to the Detrex water treatment system and proposed methods for minimizing run-on waters and minimizing exposure of contaminated materials.

B. Submit a Conceptual Plan for the diversion dam, pumping equipment, and power supply and a Contingency Plan for operation and maintenance of the diversion dam components.

PART 2 – PRODUCTS

(Not Used.)

PART 3 - EXECUTION

3.1 TEMPORARY DAM AND DIVERSION

A. Contractor shall install a temporary dam at the location identified on the Contract Drawings. The dam and associated pumping equipment will be capable of routing the volume of runoff for the 10-year, 24-hour design storm.

B. Contractor shall install, operate and maintain two equivalent primary and back-up pumps for routing of surface water from the diversion dam around the work area in the DS Tributary. Each pump shall have a minimum capacity of 2,000 gallons per minute (gpm) and be configured for automated operation.

C. Contractor shall route the water in closed conduit to a discharge location in the concrete box culvert downstream of the location of the slurry wall. Contractor shall install an additional dam in the culvert upstream of the discharge location, if necessary to prevent backflow of the discharge into the work area.

D. Contractor shall operate and maintain the dam and diversion system throughout the duration of the work activities in and around the DS Tributary (slurry wall crossing, groundwater recovery crossing, DS Tributary recovery trench installation and rail spur replacement). Contractor shall cease operation and maintenance of the system only after receipt of verbal and written confirmation from the Engineer.

E. The Contractor shall employ construction techniques and equipment that minimize potential environmental impact and which comply with the contractor Health and Safety Plan. In the event the Engineer determines that the Contractor is employing

inappropriate procedures or equipment, the Engineer shall issue a written order establishing the limits of acceptable procedures and noting acceptable equipment. The Contractor shall revise procedures or use other approved equipment at Contractor's sole expenses.

3.2 GROUNDWATER RECOVERY SUMP

A. Contractor shall install a temporary groundwater recovery sump at the location identified on the Specification Drawings. Dewatering will be performed, as necessary, to facilitate installation of the groundwater collection trenches and the slurry wall.

B. Contractor shall install a pump in the temporary groundwater recovery sump to dewater the work area. The pump shall have a minimum capacity of 100 gpm and the discharge shall be routed via close conduit to Pumping Station No. 2 or other location on the Detrex property whereby the discharge would ultimately be treated by the Detrex water treatment system.

C. Contractor shall operate and maintain the groundwater recovery sump, as necessary, during work activities in and around the DS Tributary (slurry wall crossing, groundwater recovery crossing, DS Tributary recovery trench installation and rail spur replacement). Contractor shall cease operation and maintenance of the system only after receipt of verbal and written confirmation from the Engineer.

3.3 HEALTH AND SAFETY CONSIDERATIONS

A. Contractor shall perform all handling of excavated materials and recovered water in strict accordance with the Contractor's approved Health and Safety Plan and Section 01030 of these specifications.

B. Contractor shall decontaminate all equipment that was used to handle contaminated soil before leaving the site in accordance with the Contractor's approved Health and Safety Plan.

C. Contractor shall provide all necessary safety personnel and equipment, including protective gear, emergency equipment, monitoring equipment, and decontamination facilities required for handling the contaminated soil in accordance with the Contractor's approved Health and Safety Plan.

END OF SECTION 02170

SECTION 02200
EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, services and incidentals necessary to perform all earth excavation, ground water control, sheeting and shoring, backfilling, compacting and grading for all structures, pipelines and utilities.

B. The Contractor shall perform all grading work indicated on the Drawings or as specified by the Engineer. The surface area of the site, including all excavations, cuts, fills and embankments, shall be finished to the lines, grades and cross-sections shown on the Plans, and shall be cleaned of all loose material.

Erosion control procedures, including riprap, geotextile, mulching, baling, and silt fencing shall be utilized along trenches, soil stockpiles, slurry trench operations, and temporary and final drainage structures. Erosion control shall occur as required and immediately prior to start of work.

C. It shall be the Contractor's responsibility to investigate the actual conditions existing at the site. No extras will be allowed for any excavations, imported fill, disposal of excess excavated material or material unsuitable for grading, nor for any conditions which would have been foreseen by thorough examination of the site, the Drawings and Specifications.

D. The Contractor shall perform all excavation for the installation of the work under his Contract including all trenching, backfilling, grading and embankment work to the lines and grades indicated on the Drawings, herein specified, or specified by the Engineer. The work shall include, but not be limited to, excavation for the structures, manholes and chambers, pipes, pavements and ditches; all bedding, backfilling and fill material; embankment construction, protection of excavations, structures and utilities above and below grade requiring sheeting, shoring and bracing; handling of water, including pumping and bailing; dewatering as required; restoration of surfaces; filling unauthorized excavations, disposal of surplus materials and all incidental work.

1. Trenches and other excavations shall be properly sheeted, shored and braced as necessary to prevent shifting of materials; to prevent damage to structures, pavement and pipes; and to provide safe working conditions.

The Contractor shall be responsible for the adequacy of all sheeting and bracing used and for all damage resulting from its failure or from placing, maintaining and removing it.

2. Where there are existing utilities, such as water mains, gas lines, electric conduits, etc., the Contractor shall uncover said pipes by hand digging as appropriate, and structures a sufficient time in advance of the construction of the proposed work to definitely determine the line and elevation of the existing structures with reference to the new work so that, if required, change in line and/or grade can be made in the new work. The Contractor shall be responsible to advise all utilities and agencies of the extent, scope and schedule of his operation.

3. The Contractor shall be responsible at all times for carrying out excavation and trenching work in a safe and prudent manner, to protect the workers and public from unreasonable hazard. All applicable local, State and/or Federal requirements shall be observed and necessary permits acquired by the Contractor.

E. Definitions

1. The term "earth excavation" as herein defined shall be construed to mean all classes of material, wet or dry, and shall include so-called muck, hardpan, soft shale or slate, old macadam, topsoil, sod, masonry, and boulders up to 2 cubic yard in volume, all of which can be readily removed with a pick, trenching machine or backhoe equipment.

1.2 RELATED SPECIFICATIONS

A. Division 1 General Requirements

B. Section 02130 Contaminated Materials Handling

C. Section 02168 Soil-Bentonite Slurry Wall

D. Section 02618 Culverts

E. Section 03300 Cast In-Place Concrete

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Excavated Material

1. Excavated materials to be reused shall be stored in locations that will not interfere with construction operations.

2. Unsuitable and surplus excavated material and debris shall be disposed of

by the Contractor at his own expense outside the limits of the project site.

B. Riprap

1. Riprap shall consist of a durable field or quarry stone. All stones shall weigh from 50 to 400 pounds each. At least 50% of the stones shall weight in excess of 100 pounds. The stones shall be free of dirt, debris or deleterious material.

2. Surface stones and boulders which exist in some site areas may be used for riprap providing they are suitable for the use specified, and are acceptable to the Engineer.

C. Geotextile

1. The geotextile fabric shall be a non-woven polyethylene or polyester material meeting or exceeding in the following criteria, based on the associated test methods:

Property	Test Method	Requirements
Weight Equivalent	ASTM D-3776	Min. 8 oz/sy
Apparent Opening Size (US Standard Sieve)	COE CW02215-77	Max. 70-100
Puncture Strength	ASTM D-3787	Min. 145 lbs.

2. The geotextile shall be placed and anchored on a prepared surface approved by the Engineer. The geotextile shall be laid loosely so that placement of the overlaying materials will not stretch or tear the geotextile.

3. Riprap shall not be dropped onto the geotextile from a height greater than one (1) foot. Placement of the rip-rap shall begin at the toe and proceed up the slope. The drop height shall be reduced if drop damage occurs and any damaged sections shall be repaired or replaced.

1.4 JOB CONDITIONS

A. Protection of Property

1. Necessary arrangements shall be made by the Contractor with all persons, firms and corporations owning or using any poles, pipes, tracks or conduits, etc., affected by the construction included under these specifications Contract to maintain and protect such facilities during construction. The cost of any such protection shall be paid by the Contractor. Contractor shall contact the Ohio Utility Protection Service at 1-800-362-2764 at least 72 hours prior to any construction activities to verify the presence/absence of utilities within the proposed construction area.

2. Excavated materials shall be deposited only in designated areas. The Contractor shall avoid depositing excavated material on pavements, sidewalks or grass plots, except with written authorization, and then only when adequate temporary provisions have been made for passage and protection of pedestrians and vehicles. Adequate bridging and planked crossings must be provided and maintained across all open trenches for workers.

3. The Contractor shall shore up or otherwise protect all fences, buildings, walls, or other property adjacent to any excavation that might be disturbed during the progress of the work. The Contractor shall be liable for any damage which may result to neighboring property from excavation, backfill or grading operations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Earth Fill

1. Earth fill shall be fine, material from the excavations, free from trash, frozen lumps, organic substances, rocks over 4 inches in diameter or other materials which cannot be properly compacted. Physical properties shall be such that it can be readily spread and compacted.

B. Select Granular Backfill

1. For pipelines and groundwater interceptor trenches.

a. Select granular backfill shall be No. 2 run-of- crusher stone, per

Ohio DOT Specifications gradation and for physical requirements, latest edition.

b. Slag will not be allowed.

2. For Structures

a. Select granular backfill shall be No. 2 stone, per Ohio DOT Specifications for gradation and for physical requirements, latest edition.

b. Slag will not be allowed.

C. Pipe Bedding Materials

1. Unless otherwise indicated on the Drawings, pipe bedding material shall be Ohio DOT Size Designation No. 1 Crushed Stone, latest edition, with the following gradations:

a. 100 percent (by weight) of the material shall pass screens with 1" square opening

b. 90-100 percent (by weight) of the material shall pass screens with ½" square opening

c. 0-15 percent (by weight) of the material shall pass screens with ¼" square openings

2. Crushed stone for bedding pipe shall meet all the requirements of Ohio DOT latest edition, and shall consist of clean, durable, sharp angled fragments of rock of uniform quality. Crushed stone for bedding pipe shall be obtained from sources conforming to the requirements of the Ohio DOT as to sampling, testing methods, quarry reports and any other required procedures.

3. Slag will not be allowed.

D. Riprap:

1. Riprap shall meet all the requirements of Ohio DOT, Section 601.

PART 3 - EXECUTION

3.1 EXCAVATION

A. General Requirements

1. Excavation shall be made to such widths as will give suitable room for

construction of the structures, for forms, sheeting, bracing and supporting, pumping and draining; and the bottom of the excavations shall be rendered firm and dry and in all respects acceptable to the Engineer.

2. Excavation and dewatering shall be accomplished by methods that preserve the undisturbed state of subgrade soils. Subgrade soils that become soft, loose, "quick", or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by concrete or granular fill as required by the Engineer at the Contractor's expense.

B. Excavation

1. Excavations shall be carried to the depth and dimensions necessary for the proper installation of all work as detailed on the Contract Drawings. Unless specifically directed by the Engineer, excavation shall not be made below the elevations indicated on the Contract Drawings. Where any unauthorized excavation is made below the grades indicated, the excavations shall be restored to the proper elevations with compacted, clay material. In any event, the operations necessary to correct an excess of excavation shall meet with the consent of the Engineer. If deemed necessary, concrete instead of clay fill shall be used to correct unauthorized excavations.

C. Trench Excavation

1. The Contractor shall excavate trenches to the depth necessary for proper placing of pipe. The trench width at the crown of the pipe shall be kept to a minimum, allowing only the space necessary for proper pipe laying and bedding.

2. In some circumstances trench width may vary depending upon the depth, nature of material excavated, and method by which excavation is accomplished. In any case, sufficient clearance around the pipe shall be provided to properly lay the pipe, make the joint, and install and compact the backfill.

3. Above the crown of the pipe, the trench shall be kept as narrow as practical, with sides as nearly vertical as consistent with good workmanship and safety. The trench dimensions and procedure of trench excavation shall be subject to the acceptance of the Engineer.

4. The trench shall be opened a minimum distance ahead of pipe laying as accepted by the Engineer.

5. The trench shall be braced, sheeted and dewatered, as necessary and as required to provide safe firm and dry conditions, and shall comply with all requirements of these Specifications.

6. The Contractor shall exercise care to avoid damage to existing structures, utilities, and pipes in the performance of the work. In locations where the excavation is carried beneath or adjacent to existing structures, utilities, or pipes, the Contractor shall furnish and install sheeting and bracing as necessary to support such structures, utilities or pipes in their original position, and shall be responsible for any damage caused to such utilities by his work. The support or bracing of existing utilities shall be acceptable to the utility company having ownership and/or jurisdiction of the existing utility.

3.2 BACKFILLING

A. Requirements

1. All trenches and excavation shall be backfilled to the original surface of the ground or to such other grades as may be shown on the plans or directed by the Engineer.

2. For all bedded pipe line construction, the bedding material shall be installed, graded and compacted prior to placing the lengths of pipe in the trench. No other method shall be allowed unless authorized in writing by the Engineer.

3. The method and degree of compacting backfill will be governed by the type of material and the extent to which any subsequent settlement can be permitted.

B. Placement of Fill Material

1. In all backfilling of trenches and around structures, loose lumber, braces, rubbish and refuse shall be removed from the areas to be backfilled.

2. Backfilling shall be done with sound material, free from waste, objectionable organic matter, rubbish, boggy or other unsuitable materials. No frozen material shall be used for backfilling.

3. Backfilling shall begin as soon as practicable after structures and pipelines have been installed and inspected. Material for bedding and backfill shall be as shown on the Drawings and as specified. The material shall be firmly compacted below and around conduits and pipelines. Temporary

blocking shall not be allowed.

4. Backfill shall be placed in uniform horizontal layers and shall be tamped or otherwise consolidated as the work progresses. In no case shall the consolidated layers of backfill be more than 6 inches in thickness. Lumps of earth shall be broken up and if there are any stones or lumps that cannot be readily broken up; they shall be distributed throughout the mass so that all interstices are solidly filled with fine materials.

5. The backfilling around and over conduits and pipes shall be carefully done by hand and tamped with suitable tools, to a point two feet above the top of such conduits and pipes. This material shall be placed in layers approximately 6 inches thick, each layer being thoroughly tamped and compacted in place. No stone fragments shall be placed in the backfill nearer than 2 feet from the pipe or conduit at any point.

6. The remaining upper portion of the trench may be backfilled by machine, but the work shall be done in such a way as to prevent dropping of material directly on top of the conduit or pipe through any great vertical distance.

7. For Pipe Lines, Chambers and Manholes - Backfill in areas of concrete slabs, foundations and fill in graded areas shall be compacted to 95% for granular materials as determined by AASHTO Standard Method T-99.

8. For Structures - Backfill in areas of concrete slabs, foundations and fill in graded areas shall be compacted to 95% for granular materials.

3.3 COMPACTION OF MATERIALS

A. It shall be the Contractor's responsibility to properly place and compact all materials and to correct any deficiencies resulting from insufficient or improper compaction of such materials. The Contractor shall determine the type, size and weight of compactor best suited to the work at hand, select and control the lift (layer) thickness, exert proper control over the moisture content of the material, and other details necessary to obtain satisfactory results.

B. Compaction Equipment

1. The selection of compaction equipment is the Contractor's responsibility, but shall be subject to the approval of the Engineer. Generally, the following shall apply for the type of material to be compacted.

2. Sheepsfoot rollers shall be used to compact clay and glacial till soils. The

proper ballasted weight shall be determined such that the feet penetrate to their full length on a loose lift to be placed, and with further passes, compact the layer as required.

3. Pneumatic or vibratory rollers shall be used to compact sands and gravels. Pneumatic rollers shall have operating weights between 2,000 and 3,500 pounds per tire.

4. Smooth steel wheel, pneumatic tired or vibratory rollers shall be used to compact slag, coarse gravel or crushed stone. Smooth steel wheel rollers shall have a minimum weight of 10 tons. Where possible, rock fill shall be compacted using a self-propelled vibratory steel drum roller weighing at least 10 tons.

5. In all cases, loads shall be adjusted to give the most suitable results for the material being compacted. For heavier, or more efficient types of approved compaction equipment, the minimum number of passes required on all portions of each successive layer shall be determined by the Engineer after appropriate field tests to evaluate the efficiency of the equipment have been made. However, layer thicknesses shall not, under any circumstances, exceed those specified.

In confined areas, and adjacent to utilities, compaction of granular materials shall be made using hand guided mechanical vibratory plate tampers or rollers similar to units manufactured by Kelly, Jay Jackson, or Ingersoll Rand.

In confined areas, and adjacent to utilities, compaction of clay and glacial till soils shall be made using a jumping jack or similar equipment.

3.4 SITE GRADING

A. Grading in preparation for placing of topsoil, planting areas, paved walks and drives and appurtenances shall be performed at all locations indicated on the Specification Drawings, to the lines and grades shown and as directed by the Engineer. All material encountered, of whatever nature, within the limits indicated, shall be removed and disposed of as directed. During the course of grading, the subgrade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.

B. When access roads are no longer needed, road fill shall be removed and the access area shall be restored. Care shall be taken to avoid damage to adjacent vegetation

and to prevent the formation of depressions that would serve as mosquito pools.

C. If at the time of grading it is not possible to place any material in its proper section of the permanent structure, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.

D. The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses.

E. All loose or protruding rocks shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings or as directed by the Engineer.

F. Rough grading shall be stopped four inches below final grade and leveled off, and topsoil shall be placed and finished to final grade.

G. The Contractor shall replace all surface material, and restore paving, curbing, sidewalks, gutters, fences and all other items which were disturbed by the construction so that they shall be equal to the original condition.

3.5 SITE RESTORATION

A. Upon completion of site grading, the Contractor shall restore all vegetation to a condition as near as practical to original conditions. All landscaped as well as all areas of wild growth (including areas of scrub brush) and open fields supporting plant life disturbed by construction activities shall be seeded in accordance with Section 02901 of these specifications and nurtured until a full healthy growth has been established.

END OF SECTION 02200

SECTION 02221
GROUNDWATER COLLECTION TRENCHES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The work involves excavation and installation of the pipe and bedding for two, separate and distinct groundwater collection trenches. This work must be coordinated with the installation of the slurry wall.

B. The Contractor shall submit for approval the proposed method(s) for excavation of the trenches and installation of all pipe, backfill, sheet piling (if required), including tie-ins to manholes, cleanouts and other piping. It shall be the Contractor's obligation to identify all regulatory and performance requirements for successful completion of the work and for coordination with all other aspects of the project, whether or not such requirements are specifically identified in this section.

C. The first groundwater collection trench will be installed parallel to and upgradient (east) of the slurry wall to reduce the hydrostatic head pressure against the wall. The second trench will be installed beneath a surface stream (DS Tributary) for purposes of intercepting the shallow groundwater that currently discharges into the stream. The DS Tributary groundwater collection trench will drain by gravity into the slurry wall groundwater collection trench, which, in turn, drains by gravity into the Detrex Corporation Pumping Station No. 2 as shown in the Specification Drawing.

D. It is anticipated that all work will be performed in Level D Personal Protective Equipment, unless upgrades are required per monitoring results. All work will be performed in accordance with the Contractor's approved Health and Safety Plan (HASP).

1.2 RELATED SECTIONS

A. Section 01030 – Contractor Safety and Health

B. Section 01560 - Environmental Protection

C. Section 02130 – Contaminated Materials Handling

D. Section 02168 – Soil-Bentonite Slurry Wall

E. Section 02170 - Cofferdams

F. Section 02200 - Excavation and Backfill

G. Section 02271- Erosion Control

1.3 SUBMITTALS

A. The Contractor shall submit for approval his proposed method to construct the groundwater collection trenches as shown and specified, including any calculations (signed and stamped by an engineer with current license in the State of Ohio) necessary or required by the Engineer. The submittal shall include:

1. Groundwater collection trench excavation method.
2. Provisions for trench stability.
3. Groundwater collection trench pipe type and installation method.
4. Standpipe type and installation method.
5. Standpipe vault type.
6. Description of equipment to be used for construction, including the number of each.
7. Affected and non-affected soil segregation and handling methods.
8. Construction and maintenance methods for HDPE lined, bermed area with a plastic cover for stockpiling affected soils generated during construction.
9. Erosion and stormwater control methods.
10. Other pertinent information or data.
11. Sheet Pile Specifications submitted for approval.

B. The Contractor shall submit shop drawings for the collection trench standpipe method no later than four weeks after contract award.

C. The Contractor shall submit a subcontractor Worker Health and Safety Program.

D. The Contractor shall submit groundwater collection trench record drawings, which include actual elevations and grades of installed trench and the actual low permeability clay formation elevation.

1.4 PROTECTION

A. The Contractor shall protect trees and other features remaining as part of final landscaping.

B. The Contractor shall protect bench marks and existing structures, roads, sidewalks, paving and curbs against damage from vehicular or foot traffic.

C. The Contractor shall protect excavations by shoring, bracing, sheet piling, underpinning, or by other methods, as required to prevent cave-ins or loose dirt from falling into excavations. All trenching and/or excavation activities shall comply with OSHA regulation, 29 CFR 1926, Subpart P, to ensure worker safety.

D. The Contractor shall underpin or otherwise support adjacent structure(s) that may be damaged by excavation work. This includes utilities, service lines, and power poles.

E. The Contractor shall notify Engineer of any unexpected sub-surface conditions. Discontinue work in the area until Engineer provides notification to resume work.

F. The Contractor shall protect against trench sloughing into any adjacent waterway and against water intrusion from these adjacent waterways into the trench.

PART 2 - PRODUCTS

2.1 BEDDING AND FILL MATERIALS

A. Granular filter media.

1. Granular filter media shall be well graded stone or gravel obtained from an off-site gravel pit.
2. Granular filter material shall be relatively free of loose foreign debris or other trash.
3. At least 95% of granular filter media must pass 7/16-inch sieve and be retained on the 1/3-inch sieve.
4. The remaining portion of the granular filter media must be retained on the 1/3-inch sieve.
5. Maximum aggregate size allowed is 2 inch.

2.2 SLOTTED POLYETHYLENE (HDPE) PIPE AND FITTINGS

A. Groundwater collection trench piping shall be perforated corrugated high density polyethylene pipe.

B. Pipe perforations shall meet the following specifications:

1. 3 holes per corrugation
2. 120 degrees apart

3. 3/16 inch diameter holes

4. Minimum 1.4 square inch of inlet per linear foot of pipe

C. The groundwater collection trench pipe and fittings shall conform to the following reference standards:

1. ASTM F405 - Standard for Corrugated Polyethylene Tubing and Fittings.

2. ASTM N252- Standard for Corrugated Polyethylene Drainage Tubing, 3 to 10 inch diameter.

3. ASTM D3350 - Standard for Polyethylene Plastic Pipe and Fitting Materials.

4. ASTM D2321 - Standard for Underground Installation of Flexible Thermoplastic Sewer Pipe.

2.3 FILTER FABRIC

A. Filter fabric shall be 100 percent knitted polyester meeting or exceeding the following physical properties:

1. Weight shall conform to ASTM D1910 (Typical: 2.5 oz/sq. yd).

2. Mullen Burst Strength shall conform to ASTM D1117 (Typical: 75 psi).

3. Abrasion Resistance shall conform to ASTM D1175-71 (Typical: 1500 cycles[2]).

4. Tensile strength determined by ASTM D1683 (Minimum strength 300 lb. in the stronger direction, 200 lb. in the weaker direction).

5. Equivalent opening size (E.O.S.). US sieve, (opening [mm]): 20 (0.850) - 50 (0.300).

2.4 STANDPIPES

A. Standpipes shall be equal diameter as trench piping SDR (35) high density polyethylene pipe.

B. Butt fusion weld all joints. Reference standard: ASTM D3261.

PART 3 - EXECUTION

3.1 GENERAL

A. Trench shall be excavated to the dimensions shown on the drawings. If over-excavation for the purpose of facilitating the Contractor's installation

methodology is performed, it shall be done so with materials and in a manner specified and approved in the Contractor's approved installation plan. In preparation of the proposed trench construction plan, the Contractor shall be aware that waste may be located beyond the limits shown on the drawings, and that unforeseen site conditions (i.e., materials and conditions that vary from those shown on the drawings or identified in previous investigations) may be present.

B. Slotted HDPE Pipe and Filter gravel shall be installed to the dimensions, line and grade shown on the Specification Drawings.

3.2 PREPARATION AND LAYOUT

A. The Contractor shall establish extent of excavation by area and elevation. Designate and identify datum elevation.

B. The Contractor shall set required lines and levels.

C. The Contractor shall maintain bench marks, monuments and other reference points.

3.3 UTILITIES

A. The approximate location of known underground utilities is indicated on the Drawings.

B. Before starting excavation, the Contractor shall establish the location and extent of underground utilities occurring in the work area.

C. The Contractor shall notify Engineer for direction concerning the removal and/or relocation of existing utilities which are in conflict with excavation.

D. The Contractor shall maintain, re-route or extend as required, existing known utility lines that pass through the work area with the approval of Engineer at no additional cost.

E. The Contractor shall protect active utility services uncovered by excavation.

F. The Contractor shall accurately locate and record abandoned and active lines re-routed or extended.

G. The Contractor shall remove abandoned service lines from areas of excavation and cap, plug or seal such lines and identify at grade.

3.4. TRENCH EXCAVATION

A. Trenches shall be excavated to the dimensions as shown on the drawings with vertical sides, unless otherwise approved or specified, and supported using approved methods meeting OSHA requirements. Any dewatering of trench shall be performed with proper disposal methods of pumped water, as approved by the Engineer, and as indicated in this section and Section 02130 Contaminated Materials Handling.

B. Trench walls shall be shored as necessary to provide protection for persons in construction areas as per OSHA regulations for construction. Special attention shall be given to trench sidewalls and adjacent slopes that may be adversely affected by weather, moisture content, construction traffic, or other conditions.

C. Trench Bottom Preparation: The bottoms of trenches shall be excavated six to twelve inches below required pipe invert, or as shown on the Drawings, for backfilling with specified filter gravel to provide uniform bearing and support for the pipe. If unsuitable material is encountered at the specified trench bottom, those materials shall be removed and replaced in accordance with SECTION 02200: Excavation and Backfill.

3.5 DEWATERING

A. The Contractor shall submit a detailed dewatering plan for approval, if required for collection trench construction.

B. The Contractor shall keep trenches dry. Provide necessary equipment including pumps, piping and temporary drains.

C. The Contractor shall direct surface drainage away from excavated areas (trench).

D. The Contractor shall prevent water intrusion from adjacent waterways into trench.

E. The Contractor shall prevent and operate suitable pumps on a 24-hour basis to keep excavations free of water until services have been placed and backfilling is completed.

3.6 BEDDING

A. A minimum of 6 inches of granular filter media shall be placed below the collection trench pipe as bedding material.

3.7 POLYETHYLENE COLLECTION TRENCH PIPE

A. All pipe shall be carefully inspected before installation and any defective or

damaged pipe shall be rejected.

B. Joints:

1. Make joints in accordance with pipe manufacturer's recommendations and the supplemental specifications below.
2. Cut pipe accurately and squarely and install without forcing or springing.
3. Ream out all pipes and tubing to full inside diameter after cutting.
4. Remove all cuttings and foreign matter from the inside of pipes and tubing before installation.
5. Make joint connections using a split band coupler installed per manufacturer recommendations.

3.8 CONSTRUCTION TOLERANCE FOR PLUMBNESS OF STANDPIPE

A. Vertical alignment of the stand pipe shall not exceed a 1 inch horizontal variation in each 10 feet of vertical depth.

3.9 FILTER FABRIC

A. The filter fabric shall be completely continuous along the perforated collection trench pipe. Filter fabric joints must have a minimum overlap of six (6) inches.

B. The filter fabric shall be secured to the pipe in such a manner that backfill material shall not infiltrate through any overlaps.

C. Seal filter fabric at the collection trench pipe and standpipe interface such that no groundwater will enter perforations unless passing through the filter fabric.

3.10 BACKFILLING

A. Trenches shall be free of building debris, snow, ice, and water.

B. Backfill shall be completed systematically and as early as possible to allow maximum time for natural settlement and compaction.

C. Granular filter media shall be placed into the trench in such a way that it has a free fall of four feet or less; and to the depths shown on the Drawings.

D. Affected Trench Excavation Material.

1. Affected trench excavation material must be used either as trench backfill or properly managed in accordance with Section 02130 of these specifications.

E. Non-Affected Trench Excavation Material.

1. All excavated material above the groundwater table shall be considered non-affected.

2. Non-affected trench excavation material can be placed above the granular filter media up to natural ground or above the affected trench excavation, as necessary.

3. Excess trench excavation material shall be stockpiled for use as fill in the eastern portion of the site as shown on the Drawings. Material shall be placed in six-inch lifts and compacted to 90 percent of maximum dry density obtained by ASTM D698. A minimum of 12 inches of non-compacted top soil shall be placed on non-affected soil stockpile and hydromulch seed to prevent erosion.

4. Non-gravel fill materials shall be placed into trench in such a way to allow natural settlement and compaction. A method so as not to disturb or damage completed construction shall be used.

5. Backfill material shall be mounded a minimum one foot above collection trench centerline and graded to drain away from trench.

3.11 CLEAN UP

A. Surplus non-affected fill materials shall be removed from work area and consolidate on-site as designated on the Drawings.

B. Debris and rubbish shall be removed from the site.

C. Areas disturbed during construction shall be fine graded to eliminate all rough and low spots and provide positive drainage.

END OF SECTION 02221

SECTION 02271
EROSION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This specification provides requirements for completing erosion and sediment control work as shown on the drawings and specified herein.

1.2 RELATED SECTIONS

A. Section 01030 Contractor Health and Safety

B. Section 02110 Site Clearing

C. Section 02130 Handling of Hazardous Materials

D. Section 02168 Soil-Bentonite Slurry Wall

E. Section 02200 Excavation and Backfill

F. Section 02618 Culverts

1.3 SCOPE AND APPLICATION

A. Required work includes, but is not limited to, the following:

1. Provide soil erosion and sediment control for disturbed areas to divert surface water from excavation areas and minimize sediment loading to Fields Brook and its tributaries.

2. Before beginning earth-moving activities, implement the soil erosion and sedimentation controls as shown on the design drawings and contained herein.

3. Perform all work in accordance with local, state, and federal requirements. Fines and related costs resulting from failure to provide adequate protection against soil erosion and sedimentation are the obligation of the contractor.

4. Rectify and/or restitute any damages to neighboring property.

1.4 QUALITY ASSURANCE

A. For all erosion and sediment control work, the Contractor shall comply with applicable requirements of governing authorities having jurisdiction.

B. The Contractor shall plan and conduct all land-disturbing activities in a manner that minimizes (1) the size of the area to be exposed at any one time, (2) the duration of exposure, and (3) offsite sedimentation damage.

C. Surface water runoff originating upgrade of exposed areas shall be controlled to reduce erosion and sediment loss during exposure.

D. After each rainfall event with 1.0 inch or greater, or daily during periods of prolonged rainfall, all erosion control measures shall be inspected and repaired.

E. The Contractor shall remove sediment deposits after each significant rainfall event. Dispose of sediments to prevent entry into any watercourse.

PART 2 - PRODUCTS

2.1 EROSION CONTROL MATERIALS

A. Straw Bales

Provide straw bales that are either wire-bound or string-tied with bindings around sides rather than over and under.

B. Silt Fencing

Provide silt fencing that conforms to Ohio Department of Transportation requirements.

C. Crushed Stone

Provide crushed stone that conforms to the state department of transportation requirements for aggregate base course, 2-inch stone.

PART 3 - EXECUTION

A. The Contractor shall establish erosion control and stormwater pollution control measures at the beginning of construction and maintain them during the entire period of construction. Identify and be attentive to onsite areas that are subject to severe erosion and offsite areas that are especially vulnerable to damage from erosion and/or sedimentation. Implement engineering controls to minimize releases from the construction areas as shown on the specification drawings.

B. STRAW BALE BARRIERS

The Contractor shall embed each bale 4 inches, and place the bales so that the bindings are horizontal. Place them in a single row, lengthwise on the proposed line, with ends of adjacent bales tightly abutting one another. In swales and ditches, extend the barrier to such a length that the bottoms of the end bales are higher in elevation than the top of the lower middle bale.

The Contractor shall securely anchor bales by driving two stakes or rebar through each bale. Fill the gaps between bales by wedging straw to prevent water from escaping between the bales. Properly maintain or replace, as necessary, any straw bales that become clogged or otherwise deteriorate.

C. SILT FENCING

Silt fencing shall be installed in accordance with the manufacturer's recommendations at the limits of excavation along Fields Brook. Anchor the skirt in a 6-inch-deep trench.

D. DUST CONTROL

Dust generated from the performance of the work shall be controlled in accordance with Section 01030, Contractor Health and Safety.

END OF SECTION 02271

SECTION 02450
RAILROAD WORK

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The work in this section consists of the temporary removal and replacement of a section of existing rail spur that serves the Occidental Chemical Corporation facility. This rail spur lies within an easement on Detrex property. An approximate 20-foot long section of railroad track and the underlying ballast will be removed to allow for excavation and installation of a slurry wall panel and a section of groundwater collection trench.

B. Following installation of the slurry wall panel and the collection trench, the area will be backfilled to grade in accordance with the Contract Drawings and the railroad ballast, crossties and tracks will be replaced.

C. Removal of the railroad tracks and replacement of the ballast, crossties and tracks will be performed by CSX and is not included in Contractor's scope of work. Contractor shall coordinate his work with CSX.

1.2 RELATED SECTIONS

A. Section 01030 – Contractor Health and Safety

B. Section 02130 – Contaminated Materials Handling

C. Section 02168 – Soil-Bentonite Slurry Wall

D. Section 02170 - Cofferdams

E. Section 02200 – Excavation and Backfill

F. Section 02221 – Groundwater Collection Trenches

G. Section 02271 - Erosion Control

1.3 PROTECTION

A. Excavations shall be protected as described in these specifications and in OSHA 29 CFR 1926 Subpart P.

B. All necessary precautions shall be taken to protect workers from exposure to contaminated materials.

C. Surface water run-on shall be directed away from open excavations.

D. Contractor shall make every effort to minimize discharge of surface water runoff that has contacted contaminated materials. The Contractor shall devise a plan to minimize runoff discharge during contaminated materials handling compatible with Section 02271 - Erosion Control.

PART 2 – PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 RAIL, CROSSTIE AND BALLAST REMOVAL

A. CSX Maintenance-of-Way will remove the rails within the work area. Rail removal is not the responsibility of Contractor.

B. Contractor shall remove all necessary crossties and ballast within the work area. Ballast shall be appropriately sloped to an appropriate angle of repose to prevent material from intruding into the work area.

C. Contractor shall load and transport all removed ballast to the eastern portion of the Detrex property for use as fill material.

D. Contractor shall load and transport all removed crossties to a refuse dumpster to be provided by Detrex Corporation.

3.2 BALLAST AND RAIL REPLACEMENT

A. Contractor shall stage replacement rail ballast adjacent to the work area for use by CSX Maintenance-of-Way in repairing the rail spur.

B. Ballast, crosstie and rail replacement will be performed by CSX Maintenance-of-Way and are not part of the Contractor's scope of work.

C. The ballast, crosstie and rail replacement will be performed to a CSX specification.

3.3 HEALTH AND SAFETY CONSIDERATIONS

A. Contractor shall perform all handling of excavated materials and recovered water in strict accordance with the Contractor's approved Health and Safety Plan and Section 01030.

B. Contractor shall decontaminate all equipment that was used to handle contaminated soil before leaving the site in accordance with the Contractor's approved Health and Safety Plan.

C. Contractor shall provide all necessary safety personnel and equipment, including protective gear, emergency equipment, monitoring equipment, and decontamination facilities required for handling the contaminated soil in accordance with the Contractor's approved Health and Safety Plan.

3.4 TOLERANCES

A. Contractor shall survey the final in-place elevation of the backfilled area. At a minimum, field survey data shall be collected along the alignment of the slurry wall and the groundwater collection trenches and at the nodes of the uniform grid established for site survey control.

B. The final elevation of backfilled materials installed by Contractor shall be within 0.2 feet of the base grade elevations specified in the Drawings or adjustments approved by the Engineer.

C. Tolerances for the elevations of the replacement ballast and rail are beyond the Contractor's scope of work.

END OF SECTION 02450

SECTION 02618
CULVERTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Furnish all equipment and materials, and perform all labor required to manufacture, transport, place, and finish for work as shown on the drawings and as specified herein.

B. This section includes the work necessary for the installation of culverts at locations shown on the contract drawings. The term "pipe" as used herein shall be considered to include both circular, arch and Round culverts.

1.2 RELATED SECTIONS

A. Division 1, General Requirements

B. Section 02050 Demolition

C. Section 02130 Disposal of Contaminated Materials

D. Section 02200 Excavation and Backfill

E. Section 03400 Precast Concrete

1.3 QUALITY ASSURANCE

A. Pipe installation shall be performed by skilled workers. Each pipe laying crew shall have a pipe laying foreman.

B. Pipe shall be accurately installed to the lines and grades shown on the specification drawings, or as approved by the Engineer, so that pipe profile (inverts) and alignment (plan) are continuously smooth. The Contractor shall not permit any water to be trapped or pond underneath or between pipe sections.

C. All piping shall be of the type and size as shown on the specification drawings and described herein.

1.4 SUBMITTALS

A. Samples of cut sheets for piping, end sections, and appurtenances shall be submitted and approved before work is started.

B. Manufacturer's Recommendations: Where installation procedures or any part

thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer prior to installation.

C. Certification: Certified copies of test reports demonstrating conformance to applicable pipe specifications shall be submitted to the Engineer before pipe is installed.

1.5 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO) Publications.

B. Standard Specifications for Highway Bridges (1983) & Interim Specifications (1984).

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Delivery and Storage: Materials delivered to the site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris.

B. Handling: Materials shall be handled in such a manner as to insure delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 - PRODUCTS

2.1 Pipes and Fittings

A. Corrugated PE Pipe and Fittings: AASHTO M 294, Type S, with smooth waterway for coupling joints. Soiltight couplings AASSHTO M 294, corrugated, matching tube and fittings for form soiltight joints.

B. Reinforced Concrete Sewer Pipe and Fittings: ASTM C 76 *ASTM C 76M), Class III, Wall B, for gasketed joints.

C. Gaskets: ASTM C 433 (ASTM 433M), rubber.

D. Special Pipe Couplings and Fittings.
Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.

2.2 BEDDING

A. Bedding shall be in accordance with SECTION 02200 – EXCAVATION AND BACKFILL and as shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Contractor shall verify that pipe culvert trench is ready to receive work and that excavations, fills, dimensions, and elevations are as indicated on drawings and as specified.

3.2 PREPARATION

A. Excavations shall be hand trimmed to required elevations and over-excavation corrected with approved fill.

B. Large stones or other hard matter that could damage piping or could prevent the proper execution of the required bedding, backfilling, or compaction operations shall be removed.

3.3 BEDDING

A. The Contractor shall excavate pipe trench in accordance with SECTION 02200 - EXCAVATION AND BACKFILL for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated or as directed by the Engineer.

B. The Contractor shall place bedding material in accordance with SECTION 02200 - EXCAVATION AND BACKFILL.

3.4 PIPE INSTALLATION

A. Pipe, fittings, and accessories shall be installed in accordance with manufacturer's instructions.

B. Pipe shall not be displaced or damaged when placing and compacting adjacent fill.

C. The Contractor shall provide pipe bedding material under all pipes and up to the spring line of the pipe. Bedding shall be hand graded to specified grade prior to laying pipe. Bedding shall provide a firm, unyielding support along entire pipe length, including joints.

D. The line and grade of the pipe, as indicated on the specification drawings, or as established by the Engineer, shall not deviate by more than one (1) inch for line and 1/4 inch for grade, provided that such variation does not result in a reverse sloping invert.

E. The Contractor shall take the necessary precautions required to prevent foreign material from entering the pipe during the laying operations. At all times, when laying operations are not in progress, at the close of the day's work, or whenever workers are absent from the job, the Contractor shall close and block the open end of the last laid section of pipe to prevent entry of foreign material or creep of the joints.

F. Whenever cutting and/or machining of the pipe is necessary, only tools and methods recommended by the pipe manufacturer and approved by the Engineer shall be used.

G. Pipe shall not be laid or jointed in water. Pipe placement areas shall be free of water during the progress of the work.

H. Bedding materials shall be placed and firmly compacted by mechanical tamping equipment. Care shall be taken to place and compact bedding material located under pipe haunches and above trench bottom.

I. Backfill shall be placed in accordance with SECTION 02200 - EXCAVATION AND BACKFILL. Pipe trenches shall be backfilled with compacted material. The initial one (1) foot of backfill material in direct contact with the pipe shall be segregated, as necessary, so that material no larger than three (3) inches in longest dimension is present, which could damage the pipe.

3.5 JOINTS

A. Field joints shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. Field joints between pipes of differing types shall be made in accordance with recommendations of the manufacturers of both types of pipes subject to the approval of the Engineer.

B. After a joint has been made, the pipe shall be checked for alignment and grade. To assure proper pipe alignment and joint makeup, place sufficient bedding material to secure the pipe from movement before the next joint is installed.

END OF SECTION 02618

SECTION 02901
SODDING, SEEDING AND MULCHING

PART 1 - GENERAL

A. DESCRIPTION OF WORK:

1. Installation of seeded and sodded areas shall be to the extent shown on Contract Drawings and shall include supplying all seed, sod, soil conditioning materials, mulching materials and watering and the incorporation of these materials into the work as specified.

B. RELATED DOCUMENTS:

1. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

2. The Contractor shall place stockpiled topsoil in those areas requiring seeding or sod. If the quantity of stockpiled topsoil is insufficient, the Contractor shall furnish and install additional topsoil as required to complete the work.

C. QUALITY ASSURANCE:

1. Any subcontract restoration shall be to a qualified firm specializing in landscape work.

2. Topsoil: Before delivery of topsoil, furnish Owner's Agent with written statement giving location of properties from which topsoil is to be obtained, names and addresses of owners, depth to be stripped, and crops grown during past 2 years.

3. Contractor shall have a soils test done at his expense and analyzed by an approved testing agency, to determine soil amendments for topsoil and provide a copy to the Owner's Agent prior to the start of fine grading.

4. Seed: All seed specified shall meet the current specifications of O.D.O.T. as to the percentage purity, weed seed, and germination. All seed shall be approved by the State of Ohio, Department of Agriculture, Division of Plant Industry and shall meet the requirements of these specifications.

5. Contractor shall provide the Owner's Agent with a list of the seed he intends to use, including, varieties of seed, labels, and suppliers name and phone number, four (4) weeks prior to the start of seeding, for approval.

6. Sod: All sod shall meet the current specifications of O.D.O.T. for percentage of weeds.

7. The Contractor shall provide the Owner's Agent with the following information from the sod supplier:

   a. the name of the producer,
   b. the location of sod field,
   c. the date the sod was cut, and
   d. the thickness the sod was cut.

D. DELIVERY, STORAGE, AND HANDLING:

1. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

E. JOB CONDITIONS:

1. Utilities: Determine location of underground utilities and perform work in a manner, which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

2. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Owner's Agent before planting.

3. Soil Stabilization: The Contractor shall provide permanent or temporary soil stabilization to denuded areas within fifteen days after final grade is reached on any portion of the site. Any such area which will not be regraded for longer than fifteen days shall also be stabilized. Soil stabilization includes any measures, which protect the soil from the erosive forces of raindrop impact and flowing water. Applications include seeding and or mulching. The Contractor shall consider time of year, site conditions and estimated time of use for the project. If necessary, the Contractor shall coordinate soil stabilization practices with the local Soil and Water Conservation District.

4. All work shall be guaranteed for one full growing season to commence upon final acceptance of lawn work.

5. Spring-sown work shall be installed between April 1st and May 30th and Fall-sown work shall be installed between September 1st and October 15th. No permanent seeding shall take place between May 30th and

September 1st. The dates for seeding may be changed at the discretion of the Owner's Agent.

PART 2 - PRODUCTS

A. TOPSOIL:

1. Topsoil shall be furnished by the Contractor. Stockpiled material, if any, shall be utilized prior to obtaining additional topsoil.

2. New topsoil shall conform to the U.S. Department of Agriculture soil texturing triangle. Screen topsoil from clay lumps, brush, weeds, litter, roots, stumps, stones larger than 1/2" in any dimension, and any other extraneous or toxic matter harmful to plant growth.

3. Obtain topsoil only from naturally well drained sites where topsoil occurs in a depth of not less than 4". Do not obtain from bogs or marshes.

4. Soil amendments shall be added according to the soils test requirements. Amendments can include, but are not limited to fertilizer, lime, compost and organic matter.

B. SEED:

1. Seed shall be vendor mixed, delivered in original bags and shall be proportioned as follows unless otherwise noted on the plans:

Common Name	Proportion by Weight
Kentucky Bluegrass	40%
Penn Lawn Fescue	40%
Perennial Rye	20%

Supplier's name and analysis of seed is to be submitted to the Owner's Agent.

C. MULCH:

1. Mulch shall be clean straw free of seed and weed seed.

2. If hydroseeding is used, wood fiber mulching material may be used and shall consist of virgin wood fibers manufactured expressly from whole wood chips and shall conform to the following specifications.

- Moisture content : 10.0% + 3.0%

- Organic content : 99.2% + 0.8% O.D. Basis
- pH : 4.8 + 0.5
- Water holding capacity: (minimum) 1,000 grams water / 100 grams fiber)

Wood fiber mulching material shall be processed in such a manner as to contain no growth or germination inhibiting factors, and must contain a biodegradable green dye to aid in visual metering during application.

D. SOD:

1. Sod shall be well-rooted Kentucky Blue Grass (Poa pratensis) grown on a mineral soil and obtained from a commercial sod nursery. Sod shall be free of all noxious weeds such as wild mustard, thistles, quack grass, etc. and reasonably free from dandelions and crabgrass.

2. Sod shall have been recently mowed to a height of not more than 2 inches and shall be cut in strips not less than 3 feet long nor more than 6 feet long and shall be cut in a uniform width of not over 18 inches.

3. Sod shall be delivered to the job within 24 hours after being cut and shall be installed within 36 hours after being cut.

4. During wet weather the sod shall be allowed to dry sufficiently to prevent tearing during handling and placing and during dry weather have been watered before lifting to insure its vitality and to prevent dropping off of soil during handling.

PART 3 - EXECUTION

A. PREPARATION - GENERAL:

1. A soils test of the topsoil shall be done by the Contractor at his expense. A copy of the test shall be submitted to the Owner's Agent.

2. Rough grading must be approved prior to placing topsoil.

3. Loosen subgrade of lawn areas. Remove any stones greater than 1" in any dimension. Remove sticks, roots, rubbish, and other extraneous matter.

4. Spread topsoil to a minimum depth of 4 inches, to meet lines, grades, and elevations shown on plan, after light rolling and natural settlement. Remove sticks, roots, rubbish, stones greater than 1/2" in any dimension, and other extraneous matter. Topsoil shall be tilled thoroughly by plowing, discing, harrowing, or other approved methods. Add specified soil amendments and mix thoroughly into the topsoil.

5. Preparation of Unchanged Grades: Where seed or sod is to be planted in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare soil for planting as follows: Till to a depth of not less than 6 inches. Apply soil amendments and initial fertilizers as specified. Remove high areas and fill in depressions. Till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter. Soils test requirements apply here as well.

6. Prior to preparation of unchanged areas, remove existing grass, vegetation and turf. Dispose of such material outside of project limits. Do not turn existing vegetation over into soil being prepared for seed or sod.

7. If necessary, supply and install topsoil in areas where there is no topsoil left after vegetation has been removed in conformance to Part 2 Section A.

8. Allow for sod thickness in areas to be sodded.

9. Apply specified soil amendments at rates specified in the soils test and thoroughly mix into upper 2 inches of topsoil. Add topsoil if existing grade has less than 4" of topsoil. Delay application of amendments if planting will not follow within a few days.

10. Fine grade areas to smooth, even surface with loose, uniformly fine texture. Roll, rake, and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Remove sticks, roots, rubbish, stones greater than 1/2" in any dimension, and other extraneous

matter. Limit fine grading to areas which can be planted immediately after grading.

11. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

12. Restore areas to specified condition, if eroded or otherwise disturbed, after fine grading and prior to planting.

B. SEEDING:

1. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage. Seed shall not be sown when the ground is frozen, muddy, or when weather conditions prevent proper soil preparation, interference with sowing and/or proper incorporation of seed into the soil.

2. Sow seed using a spreader or hydroseeder. Do not seed when wind velocity exceeds 5 miles per hour. Distribute seed evenly over entire area by sowing 2 1/2 lbs. per 1000 s.f. at right angles to each other. Total amount to equal 5 lbs. per 1000 s.f. unless otherwise altered by the plans or Owner's Agent. Immediately after sowing, the seed shall be mulched and watered.

3. Mulch shall be spread uniformly to form a continuous blanket at a rate of 100 lbs. per 1,000 s.f.. Mulch shall be 1 1/2" loose measurement over seeded areas.

4. Anchor mulch using a O.D.O.T. specified SS-1 at 60 gal./ton non-toxic tackifier such as Hydro-stik, or equal, or by securing with a netting such as conwed, or equal.

5. Contractor has the option to hydroseed large lawn areas, using equipment specifically designed for such application. The rate of application of wood fiber mulching materials is 40 lbs./1,000 s.f. The Contractor shall submit data regarding the hydroseed mixture, mulch and application rates for the Owner's Agent's review and approval prior to performing the work. Contractor shall not hydroseed within close proximity to buildings and structures when unfavorable wind conditions may blow the hydroseed material onto the structure.

C. DORMANT SEEDING METHOD:

1. Seeding shall not take place from October 15 through November 20. During this period prepare the seed bed, add the required amounts of lime and fertilizer. Then mulch and anchor.

2. From November 20th through April 1st, when soil conditions permit, prepare the seed bed, lime and fertilize, apply the selected seed mixture, mulch, and anchor. Increase the seeding rate by 50 percent.

D. SODDING:

1. Do not plant dormant sod or place if ground is frozen or extremely wet.

2. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass. Anchor sod on slopes with wood pegs to prevent slippage.

3. Water sod thoroughly with a fine spray immediately after planting.

4. Upon completion, the surface of the sod shall coincide with the finished grade.

E. RECONDITIONING EXISTING LAWNS:

1. A soils test shall be required for existing lawns prior to any reconditioning. The soils test shall be done at the Contractors expense. A copy shall be submitted to the Owner's Agent prior to starting.

2. Recondition all existing lawn areas damaged by Contractors operations including storage of materials and equipment and movement of vehicles. Also recondition existing lawn areas where minor regrading is required.

3. Provide soil amendments as called for in the soils test.

4. Provide new topsoil, as required, to fill low spots and meet new finish grades.

5. Cultivate bare and compacted areas according to the topsoil specifications.

6. Remove diseased and unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from the

Contractor's operations, including oil drippings, stone, gravel, and other loose building materials.

7. All work shall be the same as for new seeding or sodding

8. Water newly planted seed or sod areas. Maintenance of reconditioned lawns shall be the same as maintenance of new lawns.

F. ESTABLISHMENT:

1. Maintain work areas as long as necessary to establish a uniformly close stand of grass over the entire lawn area .

2. Maintain lawns by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading and replanting as required to establish a smooth acceptable lawn.

3. Mow lawn areas during the period of maintenance to a height of 2 inches whenever the height of the grass becomes 3 inches. A minimum of 3 mowings is required during the period of maintenance.

4. Distribute fertilizer on the seeded area between August 15 and October 15, during the period when grass is dry. The fertilizer shall be as specified in the soils test.

5. Reseed with the seed specified for the original seeding, and at the rate of 4 lbs. per 1,000 s.f. in a manner which will cause minimum disturbance to the existing stand of grass and at an angle of not less than 15 degrees from the direction of rows of prior seeding.

6. Resodding shall be with sod as herein specified. Trenches shall be filled and resodded.

7. The Contractor shall keep all work areas watered to the extent that he determines necessary to achieve satisfactory growth.

8. Any mulching which has been displaced shall be repaired immediately. Any seed work which has been disturbed or damaged from the displacement of mulch shall be repaired prior to remulching.

G. INSPECTION AND ACCEPTANCE:

1. When seeding or sodding work is complete and an acceptable stand of growth is attained, the Contractor shall request the Owner's Agent to make an inspection to determine final acceptance.

2. Acceptance shall be based upon achieving a vigorous uniform stand of the specified grasses. If some areas are satisfactory and some are not, acceptance may be made in blocks, provided they are definable or bounded by readily identified permanent surfaces, structures, or other reference means. Partial acceptance decisions may be made by the Owner's Agent and will be for no less than 75% of the total job. Excessive fragmentation into accepted and unaccepted areas shall be avoided. Unaccepted areas shall be maintained by the Contractor until acceptable.

3. No payment shall be made until areas are accepted.

4. All seeded/sodded areas shall be guaranteed for one full growing season to commence upon final acceptance of the areas.

END OF SECTION 02901

DIVISION 3
Concrete

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Furnish all equipment and material, and perform all labor required to manufacture, transport, place, finish, and cure concrete, and place forms and reinforcing in the structures and as shown on the drawings and as specified herein.

B. Structural concrete such as applicable for pump stations, extraction wells, and sanitary clean-outs.

C. Concrete to plug pipes, other seals and fills as required.

1.2 RELATED SECTIONS

A.	Division 1	General Requirements
B.	Section 02200	Excavation and Backfill
C.	Section 02618	Culverts

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement:

1. Cement shall be Portland Cement Type II as specified in ASTM C150.

B. Aggregates:

1. Coarse aggregate: The grading of the coarse aggregate shall conform to Size 56 as given in ASTM C33. Aggregates as delivered to the mixer shall consist of clean, hard and uncoated particles. Maximum wear 50% and 500 revolutions, AASHTO T96.

2. Fine Aggregates: Aggregates shall conform to ASTM C33. For fine aggregate, the optimal grading is given in ASTM C33, Section 5.2, and the restriction on reactive materials is given in ASTM C33, Section 6.3.

C. Admixtures

1. General: The concrete shall contain an air-entraining admixture, and, at the option of the Contractor, may contain a water-reducing admixture. Calcium chloride and other accelerating admixtures and retarding admixtures shall not be used.

2. Air-entraining Admixtures: The air-entraining admixture shall conform to ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions.

3. Water-reducing Admixture: The water-reducing admixture shall conform to ASTM C494, Type A or ASTM C494 Type D.

D. Curing Materials

1. Impervious Sheet Materials: Impervious sheet materials shall conform to ASTM C171, type optional except polyethylene film which, if used, shall be white opaque.

2. Membrane-Forming Curing Compound: Membrane-forming curing compound shall conform to ASTM C309, Type 1-D or Type 2, as approved or specified herein.

E. Water:

1. Water for mixing shall conform to ASTM C94, Section 4.1.3.

F. Form Materials:

1. Forms for Exposed Finish Concrete: Plywood forms for Class A and Class B finished surface shall comply with U.S. Product Standards PS-1, "B-B (Concrete Form) Plywood" Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing the legible trademark of an approved inspection agency.

2. Forms For Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in the finished structure with plastic-face plywood, metal or other acceptable material. Provide lumber that is dressed on at least two edges and one side for tight fit.

3. Form Ties: Internal ties shall be factory fabricated bolts and rods and shall be straight and so arranged that when the forms are removed, no metal is left closer than one (1) inch to any exposed surface for all finishes. Form ties shall not be fastened to reinforcing steel or embedded parts. Form ties

shall not leave irregular holes for repair or lead to repair marks that would detract from the specified finishes. Wire ties shall not be permitted.

4. Form Coatings, Sealers and Release Agents:

5. The Contractor shall thoroughly clean all form surfaces before erection and shall coat them with a non-staining mineral oil or lacquer. The Contractor shall wipe off all excess oil prior to placing concrete and no oil shall be permitted on the reinforcing steel or other embedded items. The use of all form coatings or lacquers shall be subject to approval, and proof shall be provided of compatibility between the product to be employed, the concrete itself, and any subsequent treatment that the formed surface is to receive.

G. Design of Form Work:

1. The Contractor shall submit the designs of all form work and falsework for approval. Form work design shall conform to Chapter 1 of ACI 347. The design tables in ACI Special Publications No. SD4 "Form work for Concrete".

2. Form work shall be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials.

3. Form work shall be sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

4. Side forms of footings may be omitted and concrete placed directly against excavation only when requested by Contractor and accepted by the Engineer, both in writing.

2.2 CONCRETE MIX DESIGN

A. All concrete shall have a minimum 28-day compressive strength of 4,000 psi, a maximum water-cement ratio by weight of 0.45 and a minimum cement content of 550 pounds per cubic yard.

B. All concrete shall contain a water-reducing admixture.

C. All concrete exposed to the weather or water, or subject to freezing shall be air-entrained.

D. Slump: Concrete without high range water reducing admixture - 3 inches maximum.

E. Air Content: 4.5 to 7.5 percent.

F. Rate of Hardening

1. Concrete mixes shall be designed to produce the following rates of hardening:

a. General Concrete

i. Ambient temperatures 50°F to 85°F -- Normal rate of hardening

ii. Ambient temperatures over 80°F -- Retarded rate of hardening

iii. Ambient temperature under 50°F -- Accelerated rate of hardening

b. Mass Concreting

ii. Ambient temperatures over 40°F -- Retarded rate of hardening.

2. Mix design shall not be changed except as approved by the Engineer to maintain quality control.

2.3 CONVEYANCES:

A. All conveyances for transporting and mixing concrete shall be of type approved by the Engineer.

2.4 TEMPERATURE FOR READY-MIXED CONCRETE:

A. The maximum temperature of concrete, as placed shall not exceed 70-degree Fahrenheit for thick concrete slab and shall not exceed 85-degree Fahrenheit for all other work. Refer to ACI 318 for requirements.

PART 3 - EXECUTION

3.1 CONSTRUCTION OF FORMWORK

A. The forms shall be constructed in accordance with ACI 347 and as required to obtain accurate alignment, location, grades, and level and plumb work in finished structures. The Contractor shall provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required.

1. The forms shall be fabricated for easy removal without hammering or

prying against concrete surfaces. Crush plates or wrecking plates shall be provided where stripping may damage cast concrete surfaces. Top forms shall be provided for inclined surfaces where the slope is too steep to place concrete with bottom forms only.

2. Temporary openings shall be provided where interior area of form work is inaccessible for cleaning, for inspection before concrete placement, and for placement of concrete. Temporary openings shall be braced and set tightly to forms to prevent loss of concrete mortar.

3. The Contractor shall form intersection planes to provide true, clean-cut corners, with edge grain of plywood not exposed as form for concrete.

4. Openings in forms shall be provided to accommodate other work, including mechanical and electrical work. Items required to be built into the forms shall be accurately placed and securely supported.

B. Removal of Forms

1. Forms and supports shall not be removed until concrete has attained sufficient strength to support anticipated loads.

The listing below serves only as a guide in determining the minimum length of time required before removal of forms and is based on the use of Type II Portland Cement. When high early strength Portland Cement is used, the length of time listed below may be reduced to not less than one-third time listed, but not less than 1 day.

a. Walls in mass work . . . . . .24 hours
b. Thin walls (12 inches or less) . . . . . 48 hours
c. Columns . . . . . .7 days
d. Bottom forms and slabs . . . . . .14 days

2. The method used for form removal shall not cause overstressing of the concrete. Supports shall be removed in a manner to permit the concrete to uniformly and gradually take the stress due to its own weight. High impact methods shall not be used to remove supports.

3. The Contractor shall break back ties after concrete has cured sufficiently to maintain unbroken bond with steel rod.

3.2 PRODUCTION OF CONCRETE

A. Ready-Mixed Concrete: Concrete shall be batched, central-mixed in a stationary mixer, and transported in accordance with ASTM C94, except as otherwise

specified herein. Plant equipment and facilities shall conform to NRMCA.QC3 "Check List for Certification of Ready-Mixed Concrete Production Facilities". Truck Mixers shall conform to NRMCA TMMB1 "Truck Mixer and Agitator Standard".

3.3 PLACING

A. Concrete shall be worked into the corners and angles of the forms and around all reinforcement and embedded items without permitting the material to segregate. Concrete shall be deposited as close as possible to its final position in the forms and in so depositing, there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers approximately 1-1/2 feet in thickness with a minimum of lateral movement. Not more than 4 cubic yards may be deposited in one pile for compaction in open, unrestricted areas in the forms. In restricted areas, deposits of less than 4 cubic yards in one pile shall be required in most locations to ensure that the concrete will be thoroughly and properly consolidated. No concrete shall be deposited on previously placed unhardened concrete that has not been thoroughly consolidated, and the amount deposited in each location shall be that which can be readily and thoroughly compacted. The surfaces of construction joints shall be kept continuously wet for the first twelve hours during the 24-hour period prior to placing concrete. Free water shall be removed prior to placement of additional concrete. All concrete placing equipment and methods shall be subject to approval by the Engineer. Concrete placement will not be permitted when, in the opinion of the Engineer, weather conditions prevent proper placement and consolidation.

B. No water shall be added to the concrete after the initial introduction of the mixing water for the batch except when, on arrival at the point of truck discharge, the slump is less than that specified. Water then may be added only if authorized by the Engineer, and if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded. Such addition of water shall be controlled and shall be made in accordance with ASTM C94.

C. Interval Between Mixing and Placing: Concrete shall be conveyed from the concrete plant and placed within 1-1/2 hours or before the agitator drum has revolved 300 revolutions, whichever comes first, after introduction of the cement to the aggregates. The concrete shall be placed within 15 minutes after it has been discharged. Concrete shall be placed within 90 minutes after mixing water to cement and aggregate.

D. Cold-Weather Placing: Concrete shall not be placed without an approved procedure when the concrete is likely to be subjected to freezing temperatures

before the expiration of the curing period. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be maintained at not less than 40°F.

E. Hot-Weather Placing: Concrete shall be properly placed and finished with approved procedures. The concrete placing temperature shall not exceed 85°F. Cooling of the mixing water and/or aggregates shall be required to obtain an adequate placing temperature.

F. Concrete on Earth Foundations: Earth foundations upon which concrete is to be placed shall be clean, damp, and free from frost, ice, and standing or running water. Prior to placing concrete, the earth foundation shall have been satisfactorily compacted as approved by the Engineer.

G. Consolidation: Concrete shall be consolidated immediately after deposit in the forms by mechanical vibrating equipment. Except where otherwise approved or directed, internal vibrators shall be used. Surface vibrators shall not be used. Form vibrators shall not be used to supplement internal vibration, unless specifically approved or directed by Engineer. In no case will vibrators be permitted to be used to transport concrete within the forms.

The vibrating equipment shall, at all times, be adequate in number of units and power of each unit to properly consolidate the concrete. Spare vibrators shall be available to maintain production in the event of breakdown.

H. Placing Concrete Through Reinforcement: In placing concrete through reinforcement, care shall be taken so that no segregation of the coarse aggregate occurs.

3.4 CONCRETE FINISH:

A. Unless otherwise noted on the Contract Drawings, the following finishes shall be used as applicable.

1. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 3 inch in height rubbed down or chipped off.

2. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting,

or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

B. Finishing Unformed Surfaces

1. General: Unformed surfaces that are not to be covered by additional concrete or backfill shall be float finished to the elevations shown on the Contract Drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevations shown on the Contract Drawings and left true and regular. Exterior surfaces shall be sloped for drainage, unless otherwise shown on the Contract Drawings. Joints shall be carefully made with a jointing tool.

2. Tolerances: Tolerances for finished surfaces shall be as indicated on the Drawings and defined in ACI 117, Section 2.2.

3. Float Finish: Surfaces to be float finished, as indicated on the Drawings (Finish U1) shall be screeded, and darbied or bullfloated to eliminate the ridges and fill in the voids left by the screed. In addition, the darbying or bullfloating should fill in all surface voids and only slightly embed the coarse aggregate. Floating should begin when the water sheen disappears and the concrete will support a finisher on kneeboards. Floating should embed the large aggregates just beneath the surface; remove slight imperfections, humps, and voids to produce a plain surface; and compact the concrete and consolidate mortar at the surface.

4. Troweled Finish: Troweled finishes shall be used for floors intended as walking surface or for reception of floor coverings.

5. Broom Finish: Broom finishes shall be used for sidewalks, garage floors, ramps and walking surface exposed to the elements.

C. No finishing operations shall take place until the surfaces of the slab have set sufficiently to sustain kneeboards without damage. No injurious wheeling will be permitted on new finished surfaces of concrete, nor shall the surface be used for any load bearing purposes.

D. No traffic of any character will be permitted over newly laid concrete floors for a period of 48 hours.

E. Exterior slabs shall receive a broom finish.

3.5 REPAIR OF SURFACE DEFECTS

A. Beginning not more than 24 hours after form removal, fine and loose materials shall be removed and surface imperfections, tie holes, honeycomb and other defects shall be repaired. All unsound concrete shall be removed from areas to be repaired. Surface defects larger than 2-inch in diameter and holes left by the removal of tie rods in surfaces not to receive additional concrete shall be reamed or chipped and filled with dry pack mortar. The cement used in the mortar or concrete for all surfaces permanently exposed to view shall be a blend of Portland cement and white cement properly proportioned so that the final color when cured will be the same as adjacent concrete. Areas to be repaired shall be dampened, brush-coated with a neat cement grout, and filled with mortar or concrete. Mortar shall be thoroughly compacted in place and struck off to adjacent concrete. Replacement concrete shall be drier than the usual mixture and thoroughly tamped into place and finished. Forms shall be used if required. Metal tools shall not be used to finish permanently exposed surfaces. The repaired areas shall be cured for seven (7) days.

3.6 CURING AND PROTECTION

A. General: All concrete shall be cured by an approved method for seven (7) days. Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury, and injury from rain and flowing water. All materials and equipment needed for adequate curing and protection shall be available and at the placement, prior to start of concrete placement. Concrete shall be protected from the damaging effects of rain for 24 hours, flowing water for 14 days. All concrete shall be adequately protected from damage. No fire or excessive heat shall be permitted near or in direct contact with concrete at any time.

B. Moist Curing: Concrete which is moist-cured shall be maintained continuously (not periodically) wet for the entire curing period. If water or curing materials used, stain or discolor concrete surfaces that are to be permanently exposed, they shall be cleaned, as specified herein or as approved. When wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Horizontal surfaces shall be cured by ponding, or by covering with saturated non-staining burlap or cotton mats or sealed impervious sheet materials. The following exceptions are permitted:

1. Horizontal construction joints may be allowed to dry for 12 hours immediately prior to placing of the following lift.

2. Where insulation is approved for cold weather protection, all joints in the insulation shall be sealed to prevent moisture loss and remain sealed throughout curing period.

C. Cold Weather: The air and forms in contact with concrete sections having a minimum dimension less than 12 inches, shall be maintained at a temperature above 50°F for at least the first 3 days and at temperature above 32°F for the remainder of the specified curing period. During the period of protection and protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25°F, as determined by observation of ambient and concrete temperatures indicated by suitable thermometers.

D. Hot Weather: When necessary, provision for windbreaks, shading, fog spraying, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.

END OF SECTION 03300

SECTION 3400
PRE-CAST CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes structural precast concrete units and plant cast.

1.2 RELATED SECTIONS

A. Section 02170 – Cofferdams
B. Section 02221 – Groundwater Collection Trenches
C. Section 02618 – Culverts

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Product data and instructions for manufactured materials and products.

C. Shop drawings prepared by or under the supervision of a qualified professional engineer detailing fabrication and installation of precast concrete units. Indicate member dimensions and cross-sections; locations, sizes, and types of reinforcement, including special reinforcement; and lifting devices necessary for handling and erection.

1. Indicate layout and dimensions, and identify each precast concrete unit corresponding to sequence and procedure of installation. Indicate welded connections by AWS standard symbols. Detail loose, cast-in, and field hardware, inserts, connections, and joints, including accessories and construction at openings in precast units.

2. For precast concrete units, include structural analysis data sealed and signed by the qualified professional engineer responsible for their preparation.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver precast concrete units to Project site in such quantities and at such times to ensure continuity of installation. Store units at Project site to prevent cracking, distorting, warping, staining, or other physical damage, and so that markings are visible.

B. Lift and support units only at designated lifting or supporting points as shown on final shop drawings.

PART 2 - PRODUCTS

2.1 FORMWORK

A. Forms: Provide forms and, where required, form facing materials of metal, plastic, wood, or another acceptable material that is nonreactive with concrete and will produce required finish surfaces.

2.2 REINFORCING MATERIALS

Reinforcing Bars: ASTM A 615, Grade 60 (ASTM A 615M, Grade 400), deformed.

2.3 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type III.

Use only one brand and type of cement throughout Project, unless otherwise acceptable to Architect.

B. Normal-Weight Aggregates: ASTM C 33, Class 5S. Provide aggregates from a single source.

C. Water: Potable.

2.4 CONCRETE MIXES

A. Normal-Weight Concrete: Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1 and ACI 301, using materials to be used on the Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28-Day): 4000 psi

B. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows, with a tolerance of plus or minus 1-1/2 percent:

1. Air Content: 6 percent for 1-inch maximum aggregate.
2. Air Content: 6 percent for 1.5-inch maximum aggregate.
3. Air Content: 7 percent for 2-inch maximum aggregate.

C. Other Admixtures: Use water-reducing, high-range water-reducing, water-reducing and accelerating, or water-reducing and retarding admixtures according to manufacturer's directions.

D. Concrete-Mix Adjustments: Concrete-mix design adjustments may be proposed when characteristics of materials, project conditions, weather, test results, or other circumstances warrant.

2.5 FABRICATION

A. Formwork: Accurately construct forms, mortar tight, of sufficient strength to withstand pressures due to concrete placing operations. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116.

B. Reinforcement: Comply with the recommendations of CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.

Accurately position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcement by metal chairs, runners, bolsters, spacers and hangers, as required.

Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

C. Concrete Mixing: Comply with requirements and with ASTM C 94. Following concrete batching, no additional water may be added.

D. Concrete Placement: Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast units. Comply with requirements of ACI 304R for measuring, mixing, transporting, and placing concrete.

1. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items. Use equipment and procedures complying with ACI 309R.

2. Comply with ACI 306R procedures for cold-weather concrete placement.

3. Comply with ACI 305R procedures for hot-weather concrete placement.

E. Identify pickup points of precast concrete units and orientation in structure with permanent markings, complying with markings indicated on final shop drawings. Imprint casting date on each precast unit on a surface that will not show in the finished structure.

F. Cure concrete according to the requirements of PCI MNL-116 by moisture retention without heat or by accelerated heat curing, using low-pressure live steam or radiant heat and moisture.

G. Finish formed surfaces of precast concrete as indicated for each type of unit, and as follows:

1. Standard Finish: Normal plant-run finish produced in forms that impart a smooth finish to concrete. Small surface holes caused by air bubbles, normal color variations, and form joint marks, and minor chips and spalls will be tolerated. Major or unsightly imperfections, honeycombs, or structural defects are not permitted.

H. Finish unformed surfaces by trowel, unless otherwise indicated. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

2.6 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL-116 requirements.

B. Strength of precast concrete units will be considered potentially deficient when precast concrete units fail to comply with requirements, including the following:

1. Fail to meet compressive-strength test requirements.

2. Reinforcement does not conform to fabrication requirements.

3. Concrete curing and protection of precast units against extremes in temperature fail to meet requirements.

4. Precast units are damaged during handling and erecting.

C. Testing: When there is evidence that the strength of precast concrete units may be deficient or may not meet requirements, the Owner will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42.

1. A minimum of 3 representative cores will be taken from precast concrete units of suspect strength, from locations directed by Architect.

2. Cores will be tested, following immersion in water, in a wet condition per ACI 301 when precast concrete units will be wet under service conditions.

3. Cores will be tested in an air-dry condition per ACI 301 when precast concrete units will be dry under service conditions.

4. Strength of concrete for each series of 3 cores will be considered satisfactory if the average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.

5. Test results will be made in writing on the same day that tests are made, with copies to Architect, Contractor, and precast fabricator. Test reports will include the Project identification name and number, date, name of precast concrete fabricator, name of concrete testing agency; identification letter, name, and type of precast concrete unit or units represented by core tests; design compressive strength, compressive strength at break and type of break, corrected for length-diameter ratio, and direction of applied load to core with respect to horizontal plane of concrete as placed.

D. Patching: Where core test results are satisfactory and precast concrete units meet requirements, solidly fill core holes with patching mortar and finish to match adjacent concrete surfaces.

E. Dimensional Tolerances: Units having dimensions smaller or greater than required and not meeting tolerance limits may be subject to additional testing.

Precast units having dimensions greater than required will be rejected if the appearance or function of the structure is adversely affected or if larger dimensions interfere with other construction. Repair or remove and replace rejected units, as required, to meet construction conditions.

F. Defective Work: Precast concrete units that do not conform to requirements, including strength, manufacturing tolerances, and finishes, are unacceptable. Replace with precast concrete units that meet requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements, including installation tolerances, true and level bearing surfaces, and other conditions affecting performance of precast concrete units. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. The Contractor shall furnish and install the structure cover/lid as indicated on drawing. The installation of the lid shall be at no extra cost to the Owner.

C. The Contractor shall furnish and install the ladder according to recommendations of the manufacturer as shown on the drawings and as directed by the Engineer.

D. Asphaltic Coatings: All external concrete surfaces against which fill is to be placed shall be dampproofed to within 12 inches of final fill grade as follows:

1) Primer-One Coat of Flintguard 910-01, or approved equal, applied at the rate of 1.2 gallons per 200 square feet.

2) Protective wating - Two coats of Flintguard 810-11 or approved equal, applied at rate of 3.5 gallons per 100 square free for each coat.

END OF SECTION 03400

DRAWINGS

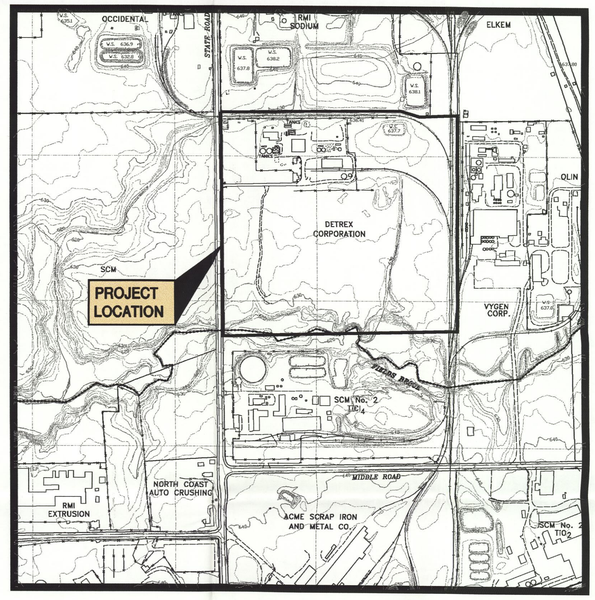
CONSTRUCTION DESIGN DRAWINGS
90 PERCENT SUBMITTAL
FOR SOURCE CONTROL REMEDIAL COMPONENTS

PREPARED FOR
DETREX CORPORATION
FEBRUARY 2000

DRAWING INDEX

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
ASHTABULA NORTH & SOUTH, OHIO
1960
PHOTOREVISED 1970

VICINITY MAP



PROJECT AREA

DETAIL NUMBER
DETAIL REFERENCE PAGE NUMBER | PAGE NUMBER OF DETAIL

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REV	DESCRIPTION OF REVISION	BY	DATE
0	REVISED 60 PERCENT DESIGN SUBMITTAL	MMS	6/2/99
1	REVISED 90 PERCENT DESIGN SUBMITTAL	KMA	2/4/00

90 PERCENT DESIGN SUBMITTAL

URS Greiner Woodward Clyde
30775 Bainbridge Road, Suite 200
Solon, Ohio 44139

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED	SD
DRAWN	GMZ
CHECKED	DAS
PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2-4-00

TITLE SHEET

SOURCE CONTROL REMEDIAL COMPONENTS
DETREX CORPORATION FACLITY
ASHTABULA, OHIO

REVISION	1
PROJECT	38.8E06011.00
DRAWING	C-1

LEGEND

- PROPERTY/PARCEL LINE
- W.S. 638.1 — APPROXIMATE ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- DETMW06S — MONITORING WELL
- GP-9 — GEOPROBE PIEZOMETER
- PROPOSED PHASE I DNAPL EXTRACTION WELL
- POTENTIAL PHASE II DNAPL EXTRACTION WELL
- AREAS TO BE FILLED AND GRADED
- AREAS TO BE GRADED
- AREAS TO BE EXCAVATED AND GRADED
- APPROXIMATE EXTENT OF DNAPL
- SLURRY WALL
- G — GROUNDWATER COLLECTION SYSTEM
- TEMPORARY SURFACE WATER DIVERSION SYSTEM

PERC = TETRACHLOROETHENE
TCA = 1,1,2 – TRICHLOROETHANE
TCE = TRICHLOROETHENE

–ALL RESULTS PRESENTED IN MILLIGRAMS PER LITER mg/l (ppm).

NOTES:

1. THE CONSTRUCTION DOCUMENTS INCLUDE THESE DEVELOPMENT PLANS AND THE ACCOMPANYING PROJECT BOOKLET SPECIFICATIONS. CONTRACTOR IS RESPONSIBLE TO MEET THE COMPLETE PROJECT REQUIREMENTS AS IDENTIFIED IN THE CONSTRUCTION DOCUMENTS AND TO REPORT ANY CONFLICTING REQUIREMENTS BETWEEN THE PLANS AND BOOKLET SPECIFICATIONS DIRECTLY TO THE OWNER'S REP. FINAL INTERPRETATION OF THE PROJECT REQUIREMENTS LIE WITH THE OWNER'S REP.

2. EXISTING SITE INFORMATION SHOWN ON THESE DRAWING IS TAKEN FROM A SURVEY BY BURGESS & NIPLE – DETREX CORRPORATION – ASHTABULA, OHIO PLANT COLLECTION & TREATMENT IMPROVEMENTS SHEET 3 OF 21 DATED AUGUST 1989 AND SURVEY BY MIDDOUGH & ASSOCIATES – ASHTABULA PLANT ADDITION SITE PLAN DRAWING NO. C1 DATED MARCH 26, 1996. THIS INFORMATION HAS BEEN PRESUMED TO BE AN ACCURATE REPRESENTATION OF THE CONDITIONS AT THE SITE. WORK PERFORMED AT THE SITE OR IN THE ADJACENT WORK AREAS SINCE THE DATE OF THE SURVEY MAY NOT BE SHOWN ON THE DRAWINGS. THE CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS AT THE SITE AND REPORT SIGNIFICANT DIFFERENCES TO THE OWNER'S REP. AND THE OWNER'S REPRESENTATIVE IMMEDIATELY.

3. THE CONTRACTOR SHALL CAUSE NOTICE TO BE GIVEN TO THE OHIO UTILITY PROTECTION SERVICE (800–362–2764) AT LEAST 72 HOURS PRIOR TO THE COMMENCEMENT OF CONSTRUCTION ACTIVITIES.

4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR SECURING ALL NECESSARY PERMITS FOR WORK.

5. THE CONTRACTOR SHALL CONFINE HIS ACTIVITIES TO WITHIN THE WORK AREAS. THE CONTRACTOR SHALL NOT TRESPASS UPON ADJACENT PROPERTIES OR RIGHTS OF WAY WITHOUT THE WRITTEN CONSENT OF THE PROPERTY OWNER.

6. DNAPL – DENSE, NON–AQUEOUS PHASE LIQUID

DEMOLITION NOTES:

1. ALL REMOVED ITEMS SUCH AS, BUT NOT LIMITED TO POSTS, LIGHTING, AND FENCING SHALL REMAIN THE PROPERTY OF DETREX CORP. ITEMS SHALL BE STOCKPILED IN A SECURED AREA AS DIRECTED BY THE OWNER.

2. THE CONTRACTOR SHALL LEGALLY DISPOSE OF ANY SURPLUS EXCAVATED MATERIAL OR CONSTRUCTION DEBRIS, OFF OF OWNERS PROPERTY.

N

0 50 100 200
APPROXIMATE SCALE IN FEET

REV	DESCRIPTION OF REVISION	BY	DATE
0	REVISED 60 PERCENT DESIGN SUBMITTAL	MMS	6/2/99
1	90% DESIGN SUBMITTAL – LOCATION OF CATALYST PILES	DAS	2/4/00

90 PERCENT DESIGN SUBMITTAL

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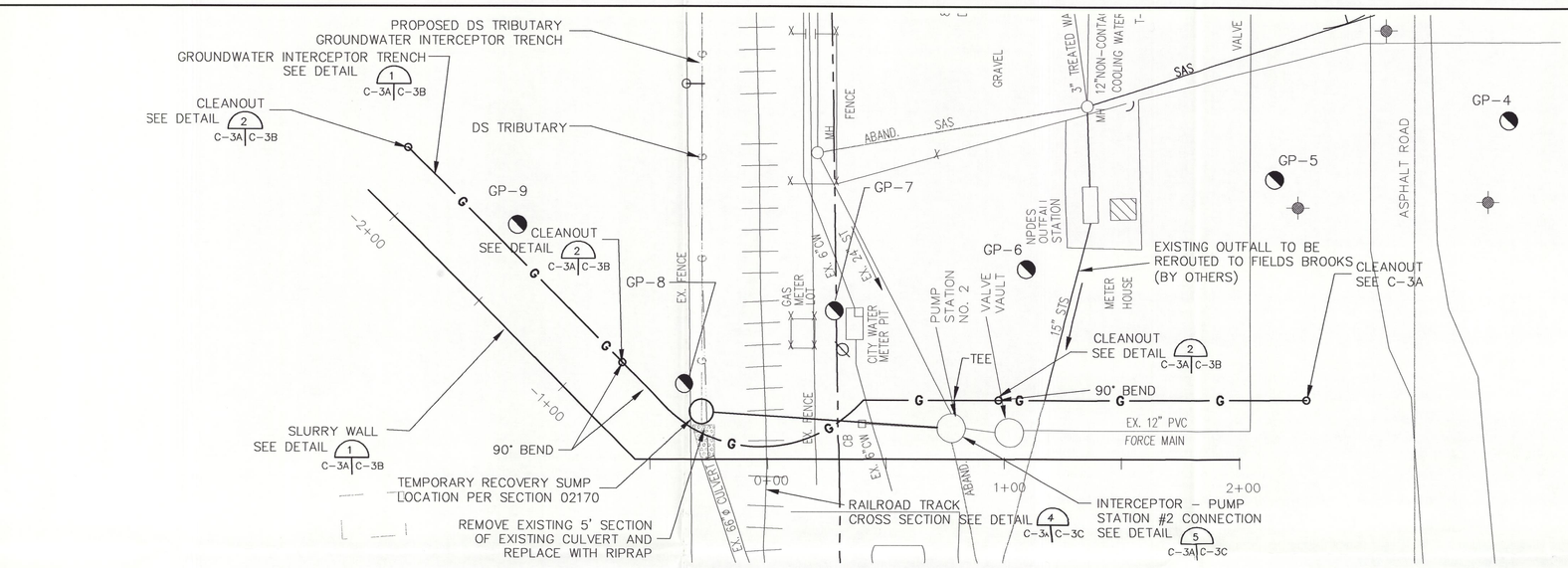
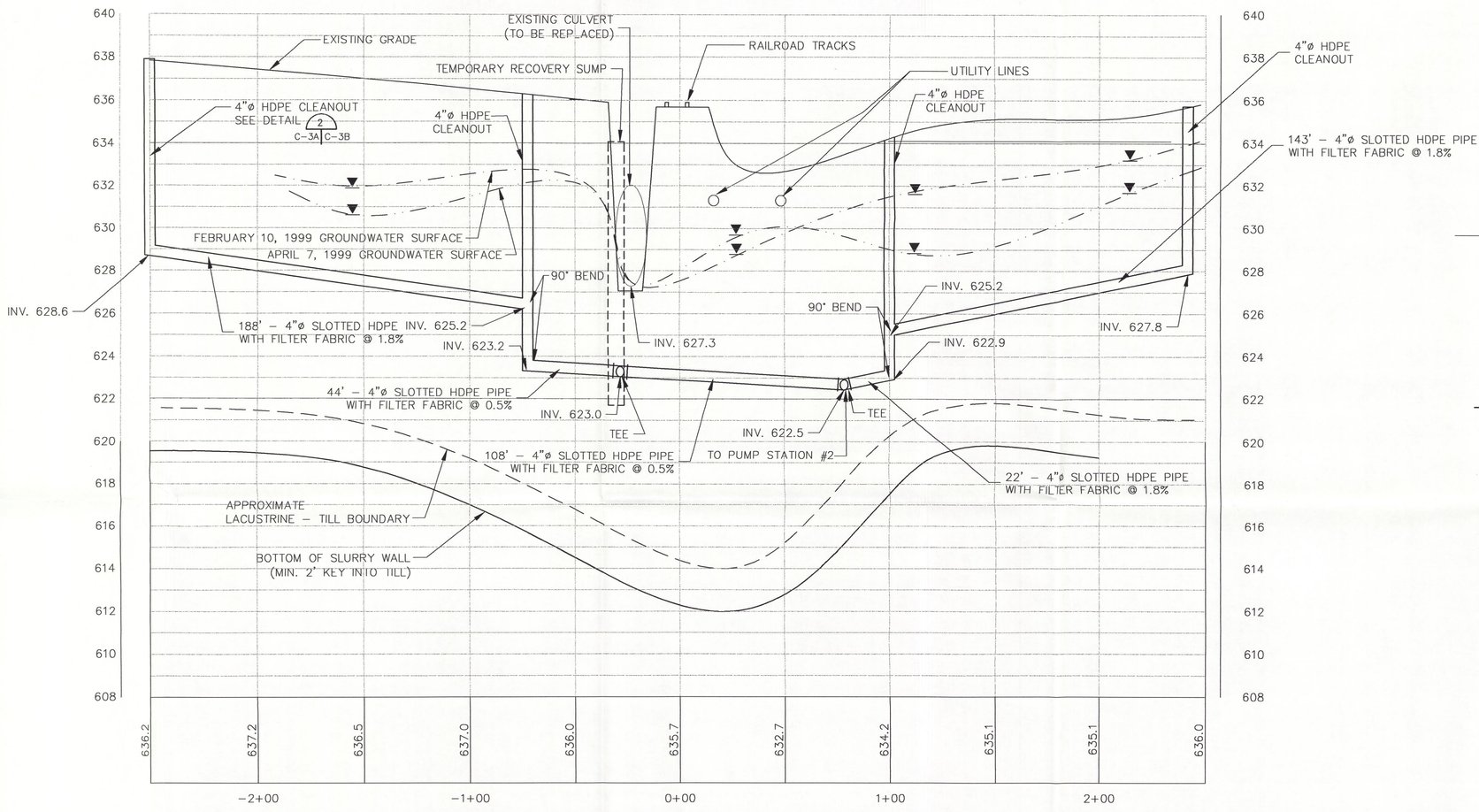
CHECKED	DAS
PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2–4–00

SITE PLAN WITH AREAS OF REMEDIATION IDENTIFIED

SOURCE CONTROL REMEDIAL COMPONENTS DETREX CORPORATION FACILITY ASHTABULA, OHIO

REVISION	1
PROJECT	38.8E06011.00
DRAWING	C-2





NOTES:

1. ANY DEFECTS IN THE CONSTRUCTION, INCLUDING MATERIALS AND WORKMANSHIP, SHALL BE REPLACED OR CORRECTED BY REMOVAL AND REPLACEMENT OR OTHER APPROVED METHOD PRIOR TO ACCEPTANCE BY THE OWNER OR THE GOVERNING AUTHORITY.

2. SAFETY OF CONSTRUCTION: COMPLIANCE WITH OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970 IS REQUIRED OF ALL CONTRACTORS ON THIS PROJECT.

3. THE CONTRACTOR SHALL CLEAN UP ALL DEBRIS AND MATERIALS RESULTING FROM HIS OPERATION AND RESTORE ALL SURFACES, STRUCTURES, DITCHES AND PROPERTY TO THEIR ORIGINAL CONDITION TO THE SATISFACTION OF THE OWNER AND GOVERNING AUTHORITY.

4. THE CONTRACTOR SHALL MAINTAIN A CURRENT SET OF APPROVED CONSTRUCTION PLANS ON THE SITE. ALL DEVIATIONS FROM THE PLANS SHALL BE RECORDED ON THE PLANS BY THE CONTRACTOR.

5. THE IDENTITY AND LOCATION OF ALL EXISTING UNDERGROUND UTILITIES KNOWN TO BE LOCATED IN THE CONSTRUCTION AREA HAVE BEEN SHOWN ON THE DRAWINGS AS ACCURATELY AS POSSIBLE. BASED ON AVAILABLE INFORMATION. THE OWNER'S REP. AND THE OWNER ASSUME NO RESPONSIBILITY FOR THE ACCURACY AND DEPTH OF THE UNDERGROUND FACILITIES SHOWN.

6. THE CONTRACTOR SHALL INVESTIGATE AND LOCATE ALL EXISTING UTILITIES AHEAD OF THE CONSTRUCTION.

7. THE SUPPORT, PROTECTION, AND RESTORATION OF ALL EXISTING UNDER-GROUND UTILITIES AND THEIR APPURTENANCES SHALL BE THE RESPON-SIBILITY OF THE CONTRACTOR. THE METHOD OF SUPPORT OR PROTEC-TION MUST BE APPROVED BY THE UTILITY OWNER.

8. AT ALL STORM DRAIN AND SANITARY SEWER INTERSECTIONS(CROSSINGS), WHERE A MINIMUM VERTICAL CLEARANCE OF ONE(1) FOOT CANNOT BE OBTAINED, ENCASE THE LOWER AND MONOLITHICALLY CRADLE THE UPPER PIPE IN 3000 PSI CONCRETE FOR THE WIDTH OF THE TRENCH.

9. THE LINE AND GRADE OF ALL DRAINS AND SEWERS SHALL BE CONTROLLED DURING THE CONSTRUCTION BY THE USE OF AN APPROVED LASER DEVICE.

10. THE LOCATION OF ALL UTILITY SERVICE CONNECTIONS SHALL BE RECORDED ON THE CONSTRUCTION PLANS MAINTAINED AT THE SITE BY THE CONTRACTOR.

LEGEND

- MONITORING WELL
- GP-9 — GEOPROBE PIEZOMETER
- SLURRY WALL
- G — GROUNDWATER COLLECTION SYSTEM

VERTICAL
0 2.5 5 10
APPROXIMATE SCALE IN FEET

HORIZONTAL
0 15 30 60
APPROXIMATE SCALE IN FEET

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0	REVISED 60 PERCENT DESIGN SUBMITTAL	MMS	6/2/99

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PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2-4-00

PLAN & PROFILE - SLURRY WALL/ GROUNDWATER INTERCEPTOR TRENCH

SOURCE CONTROL REMEDIAL COMPONENTS DETREX CORPORATION FACILITY ASHTABULA, OHIO

REVISION 1
PROJECT 38.8E06011.00
DRAWING **C-3A**

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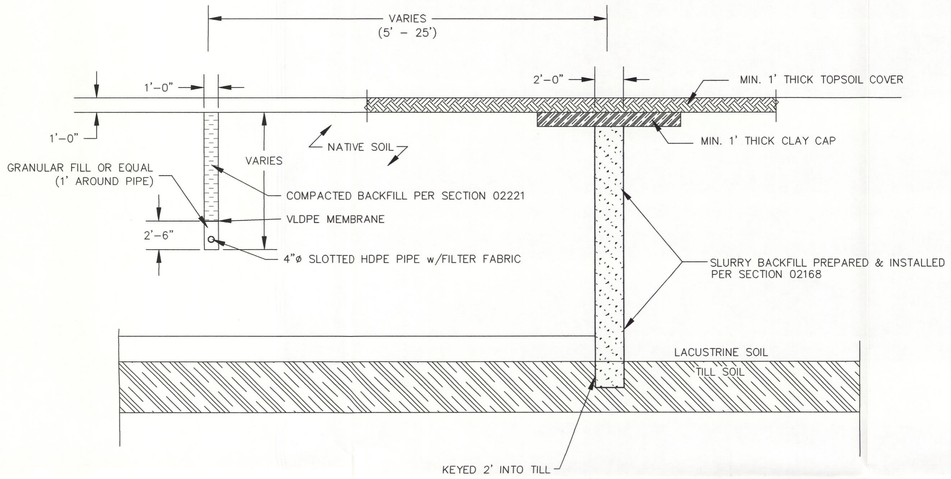
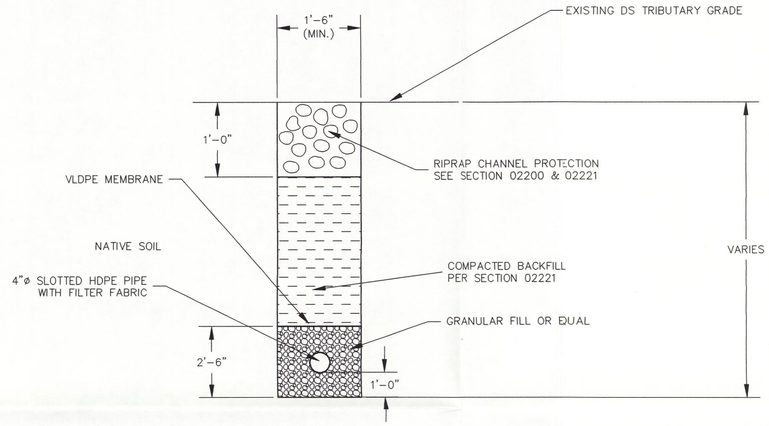


TYPICAL GROUNDWATER INTERCEPTOR TRENCH & SLURRY WALL CROSS–SECTION (1)

NOT TO SCALE

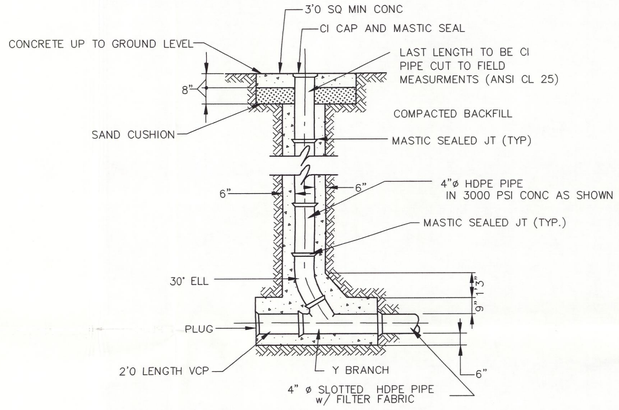
C–3A | C–3B



DS TRIBUTARY GROUNDWATER DEWATERING TRENCH; TYPICAL CROSS SECTION (3)

NOT TO SCALE

C–3A | C–3B



TYPICAL CLEANOUT (2)

NOT TO SCALE

C–3A | C–3B

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REV	DESCRIPTION OF REVISION	BY	DATE
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1	REVISED FOR 90 PERCENT DESIGN SUBMITTAL	MMS	2/4/00

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WARNING

0 ½ 1

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DRAWN	GMZ
CHECKED	DAS
PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2–4–00

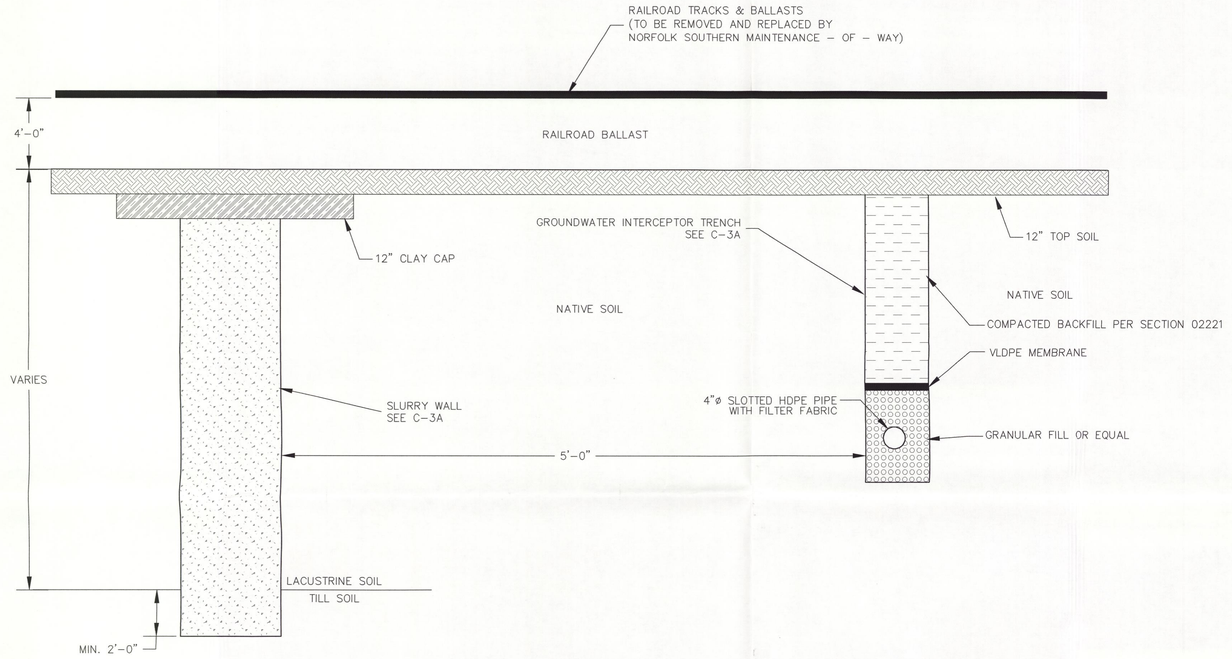
TRENCH DETAILS

SOURCE CONTROL REMEDIAL COMPONENTS
DETREX CORPORATION FACILITY
ASHTABULA, OHIO

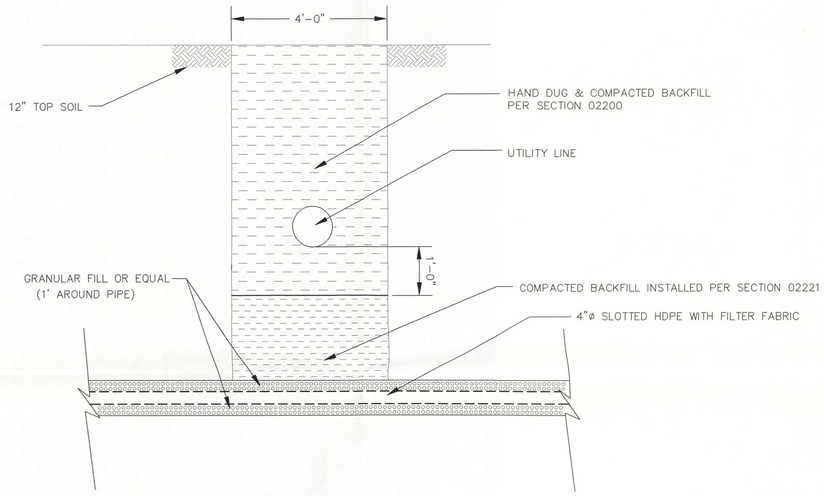
REVISION 1

PROJECT 38.8E06011.00

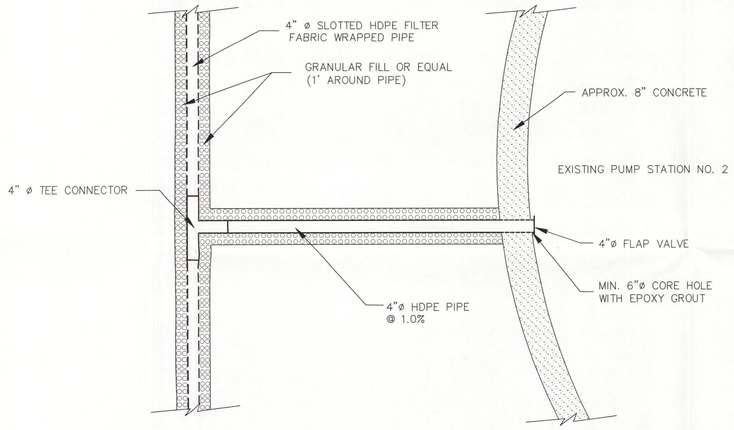
DRAWING **C-3B**



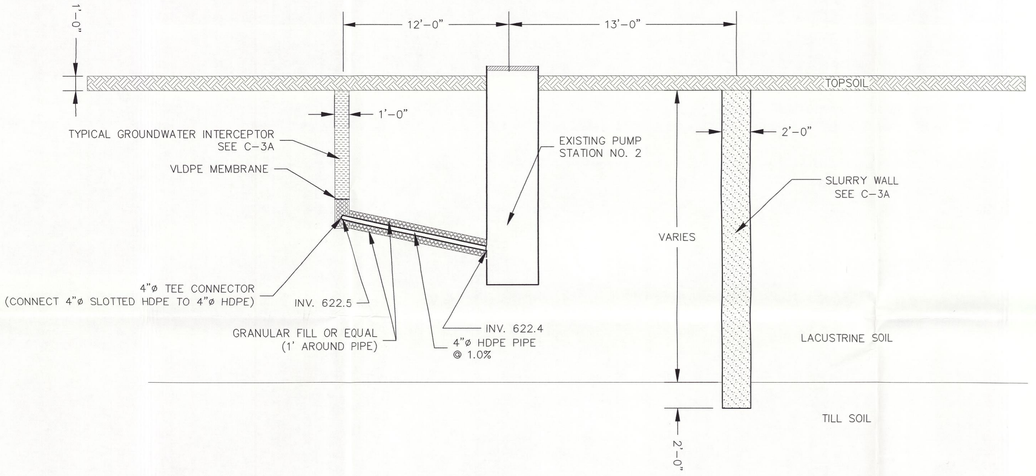
RAILROAD TRACK – SLURRY WALL & INTERCEPTOR CROSS–SECTION (4)
NOT TO SCALE
C–3A | C–3C



UTILITY LINE/GROUNDWATER INTERCEPTOR TRENCH CROSS SECTION (6)
NOT TO SCALE
C–4 | C–3C



GROUNDWATER INTERCEPTOR TRENCH – PUMPING STATION #2 CONNECTION (5)
(PLAN VIEW)
NOT TO SCALE
C–4 | C–3C



GROUNDWATER INTERCEPTOR TRENCH – SLURRY WALL CROSS–SECTION
(SHOWING INTERCEPTOR CONNECTION TO PUMPING STATION) (7)
NOT TO SCALE
C–4 | C–3C

REV	DESCRIPTION OF REVISION	BY	DATE
0	REVISED 60 PERCENT DESIGN SUBMITTAL	MMS	6/2/99
1	REVISED FOR 90 PERCENT DESIGN SUBMITTAL	MMS	2/4/00

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Solon, Ohio 44139

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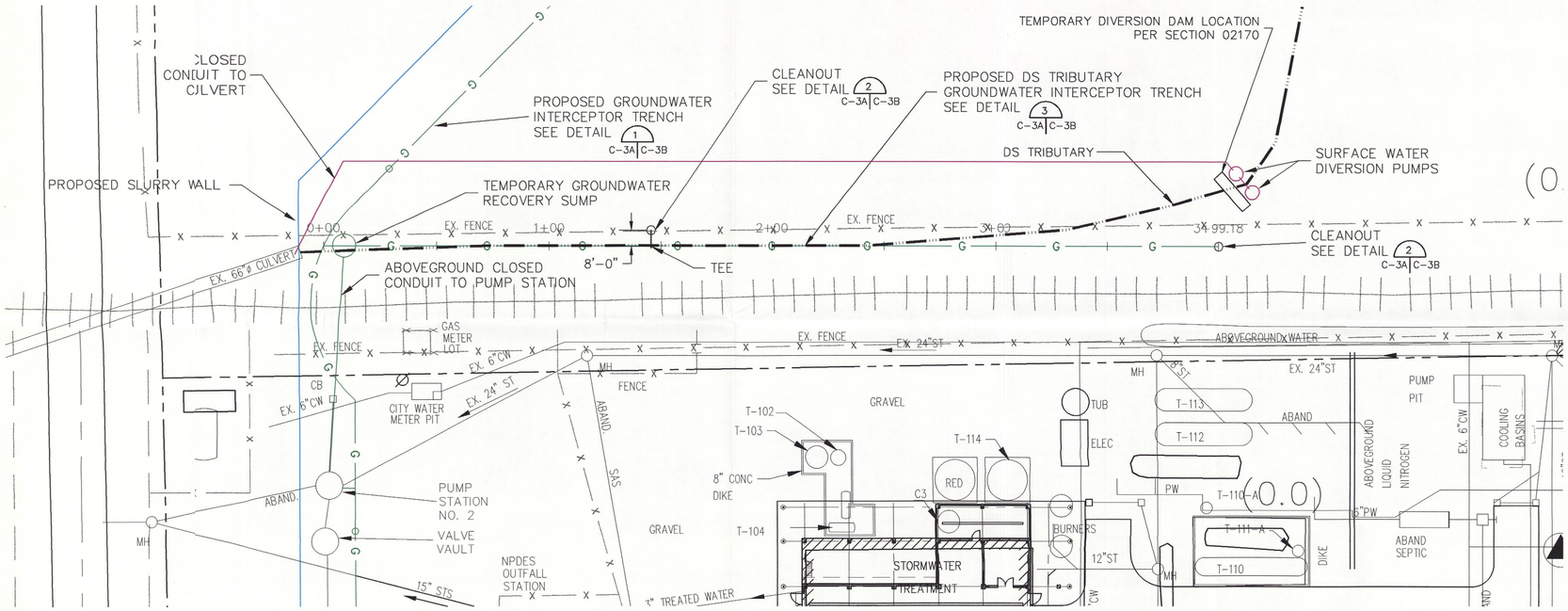
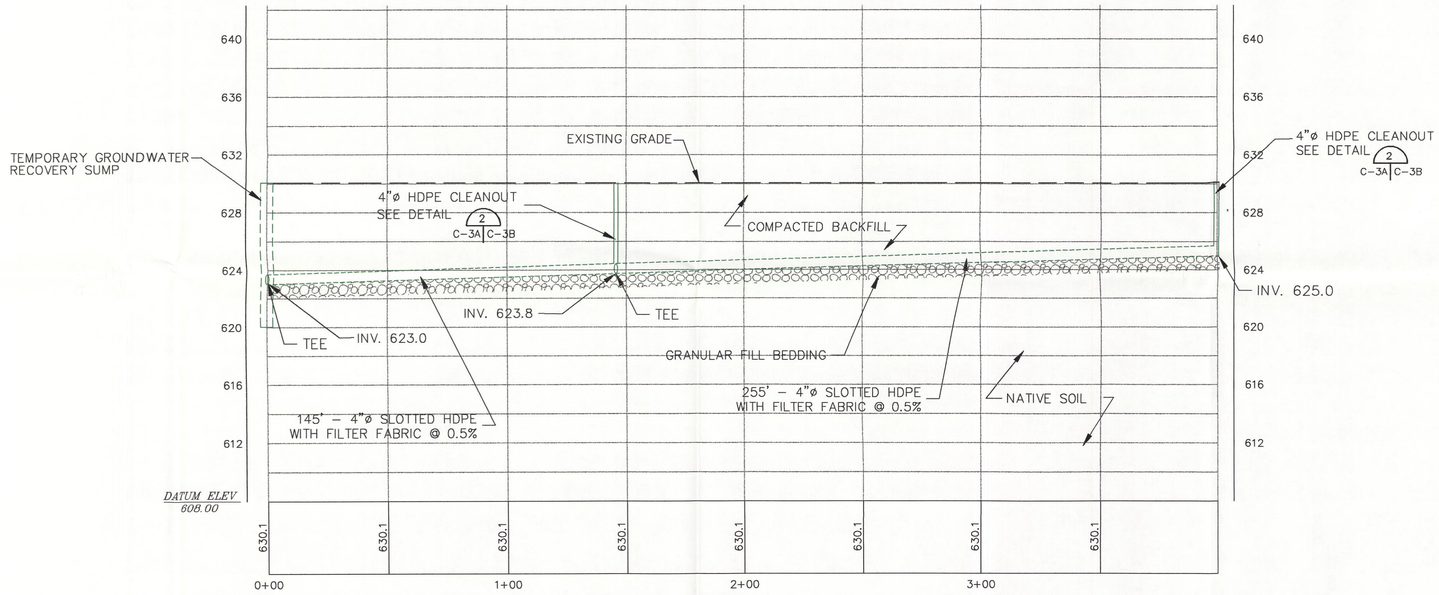
DRAWN GMZ
CHECKED DAS
PEER REVIEWED
PROJECT MANAGER MLS
DATE 2–4–00

SLURRY WALL/GROUNDWATER INTERCEPTOR TRENCH DETAILS

SOURCE CONTROL REMEDIAL COMPONENTS
DETREX CORPORATION FACILITY
ASHTABULA, OHIO

REVISION 1
PROJECT 38.8E06011.00
DRAWING **C-3C**





LEGEND

- PROPERTY/PARCEL LINE
- G — GROUNDWATER COLLECTION SYSTEM
- SLURRY WALL
- SURFACE WATER DIVERSION SYSTEM

NOTES:

1. FOR ADDITIONAL NOTES SEE C–3.
2. ALL CLEANOUTS FOR DS TRIBUTARY GROUNDWATER INTERCEPTOR TRENCH SHALL BE OUTSIDE DS TRIBUTARY.
3. SURFACE WATER DIVERSION PUMPS AND GROUNDWATER RECOVERY PUMPS SHALL BE OPERATED AND MAINTAINED FOR THE DURATION OF THE GROUNDWATER INTERCEPTOR TRENCH CONSTRUCTION PERIOD.

VERTICAL
0 2.5 5 10
APPROXIMATE SCALE IN FEET

HORIZONTAL
0 15 30 60
APPROXIMATE SCALE IN FEET

REV	DESCRIPTION OF REVISION	BY	DATE
0	REVISED 60 PERCENT DESIGN SUBMITTAL	MMS	6/2/99
1	REVISED FOR 90 PERCENT DESIGN SUBMITTAL	KMA	2/4/00

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Solon, Ohio 44139

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DESIGNED	SD
DRAWN	GMZ
CHECKED	DAS
PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2-4-00

PLAN & PROFILE - DS TRIBUTARY GROUNDWATER DEWATERING TRENCH

SOURCE CONTROL REMEDIAL COMPONENTS
DETREX CORPORATION FACILITY
ASHTABULA, OHIO

REVISION	1
PROJECT	38.8E06011.00
DRAWING	C-4

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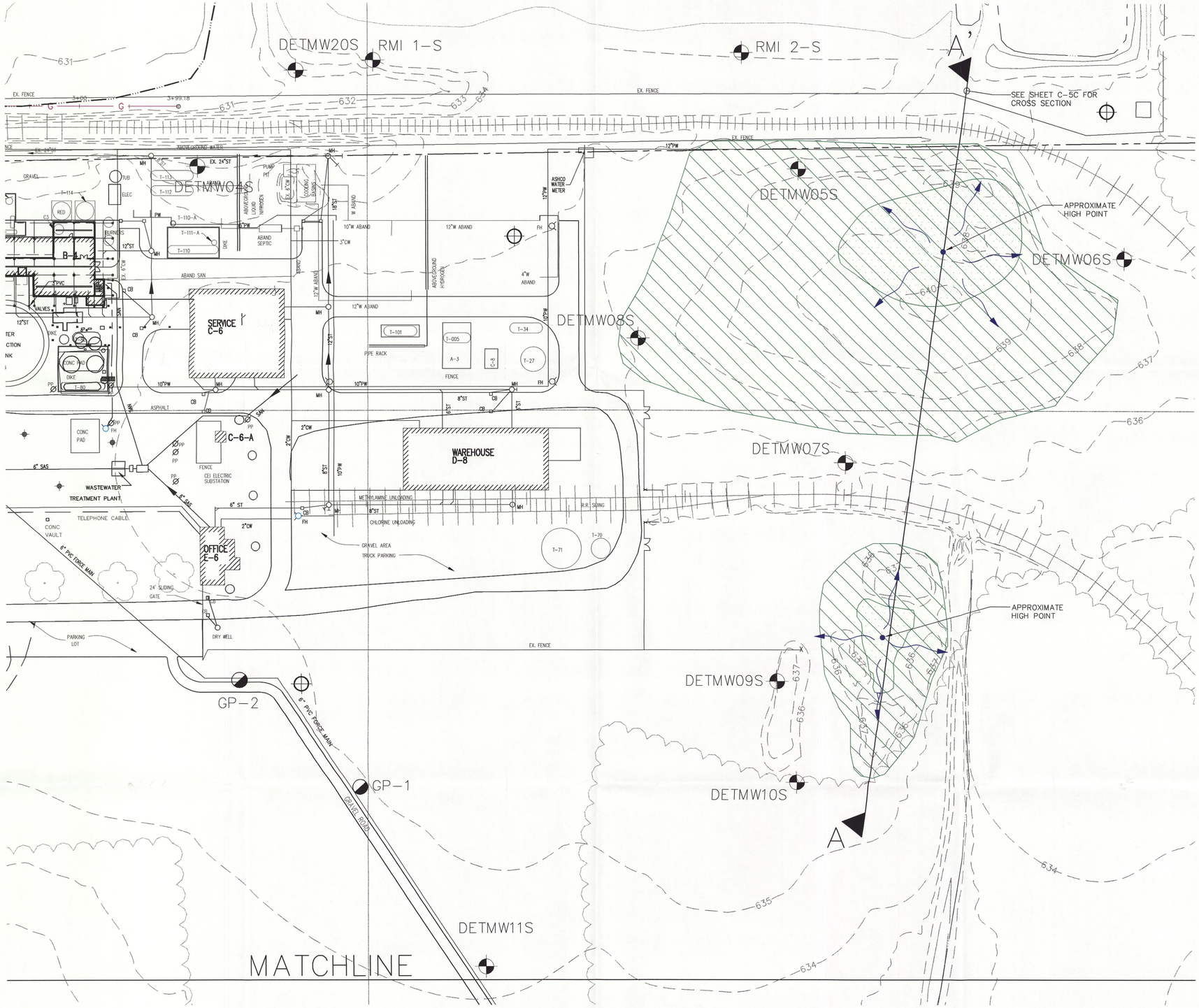

LEGEND

- PROPERTY/PARCEL LINE
- EXISTING MONITORING WELL
- GEOPROBE PIEZOMETER
- AREAS TO BE FILLED
- AREAS TO BE GRADED
- EXISTING CONTOURS
- G — GROUNDWATER COLLECTION SYSTEM
- A ▲——▲ A' CROSS SECTION LOCATION
- SURFACE RUNOFF FLOW DIRECTION

NOTES:

1. ALL GRADE ELEVATIONS SHOWN ON THIS DRAWING ARE APPROXIMATE AND MUST BE VERIFIED AT THE SITE.
2. THE CONTRACTOR SHALL MAINTAIN POSITIVE DRAINAGE AT ALL TIMES ON ALL AREAS OF THE SITE. EXCAVATED AREAS SHALL BE BACK FILLED AND GRADED SO AS TO ELIMINATE PONDING ON THE SITE.
3. EXISTING BUILDING AND UNDERGROUND UTILITY LOCATIONS WERE TAKEN FROM REFERENCE DRAWINGS. EXACT LOCATIONS TO BE VERIFIED IN THE FIELD.

N

0 25 50 100
APPROXIMATE SCALE IN FEET

REV	DESCRIPTION OF REVISION	BY	DATE
0	REVISED 60 PERCENT DESIGN SUBMITTAL	MMS	6/2/99
1	REVISED FOR 90 PERCENT DESIGN SUBMITTAL	MMS	2/4/00

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DESIGNED	DAS
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PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2-4-00

GRADING PLAN (NORTH)

SOURCE CONTROL REMEDIAL COMPONENTS
DETREX CORPORATION FACILITY
ASHTABULA, OHIO

REVISION	1
PROJECT	38.8E06011.00
DRAWING	C-5A

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MATCHLINE

DETMW11S
DRY

DETMW17S
ND

DETMW18S
NS

6" PVC FORCE MAIN
GRAVEL ROAD

APPROXIMATE LOCATION
OF CATALYST PILES
(EXCAVATE, REMOVE, AND
REGRADE AREA)

EXISTING DETENTION POND
TO BE CLEANED AND CONTOURED
(REMOVE TOP 6" OF SILT)

FIELDS BROOK

VALVE
VAULT

PUMP
STATION

CONTAINMENT DIKE

EMERGENCY SPILLWAY

630

620

627

625

634

633

632

631

LEGEND

- PROPERTY/PARCEL LINE
- w.s. 638.1 — APPROXIMATE ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- EXISTING MONITORING WELL
- EXISTING CONTOURS
- PROPOSED CONTOURS
- EXCAVATION AND GRADING AREAS

N

0 25 50 100
APPROXIMATE SCALE IN FEET

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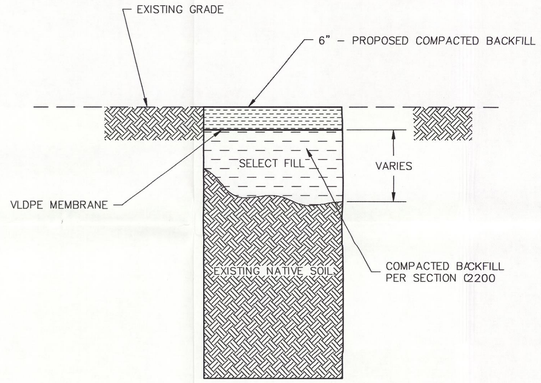
DESIGNED	DAS
DRAWN	GMZ
CHECKED	DAS
PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2-4-00

GRADING PLAN
(SOUTH)

SOURCE CONTROL REMEDIAL COMPONENTS
DETREX CORPORATION FACILITY
ASHTABULA, OHIO

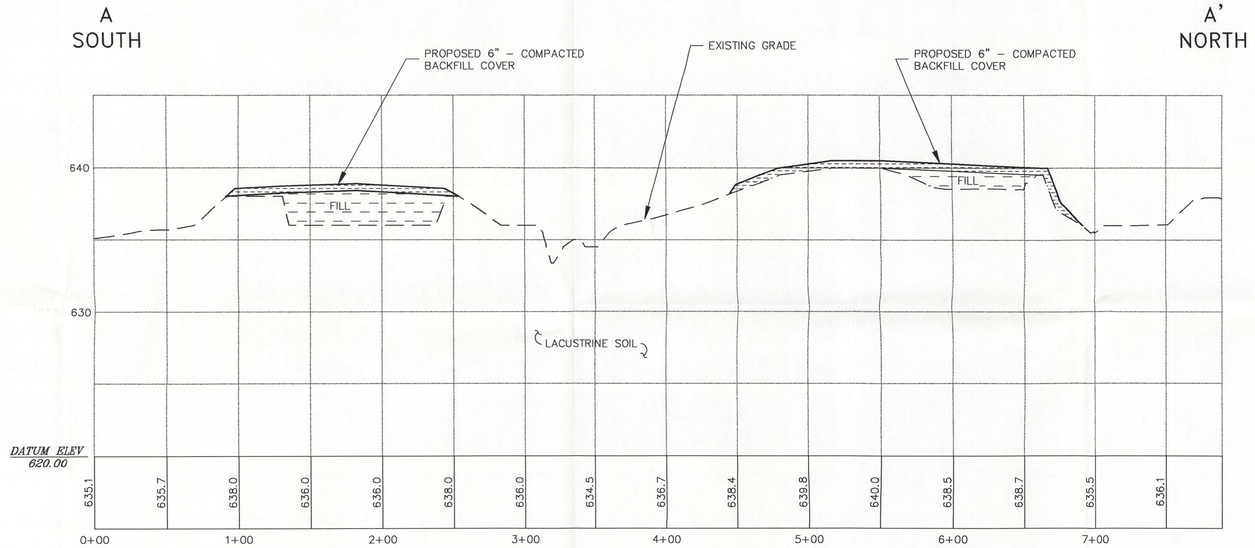
REVISION	1
PROJECT	38.8E06011.00
DRAWING	C-5B



TYPICAL FILL SECTION 8

NOT TO SCALE

C-5A | C-5C



NOTE: SEE SHEET C-5A FOR CROSS SECTION LOCATION

SECTION A-A'

VERTICAL
0 2.5 5 10
APPROXIMATE SCALE IN FEET

HORIZONTAL
0 25 50 100
APPROXIMATE SCALE IN FEET

REV	DESCRIPTION OF REVISION	BY	DATE
0	REVISED 60 PERCENT DESIGN SUBMITTAL	MMS	6/2/99
1	REVISED FOR 90 PERCENT DESIGN SUBMITTAL	MMS	2/4/00

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DRAWN	MMS
CHECKED	DAS
PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2-4-00

PROPOSED SECTION PLAN

SOURCE CONTROL REMEDIAL COMPONENTS
DETREX CORPORATION FACILITY
ASHTABULA, OHIO

REVISION 1
PROJECT 38.8E06011.00
DRAWING **C-5C**

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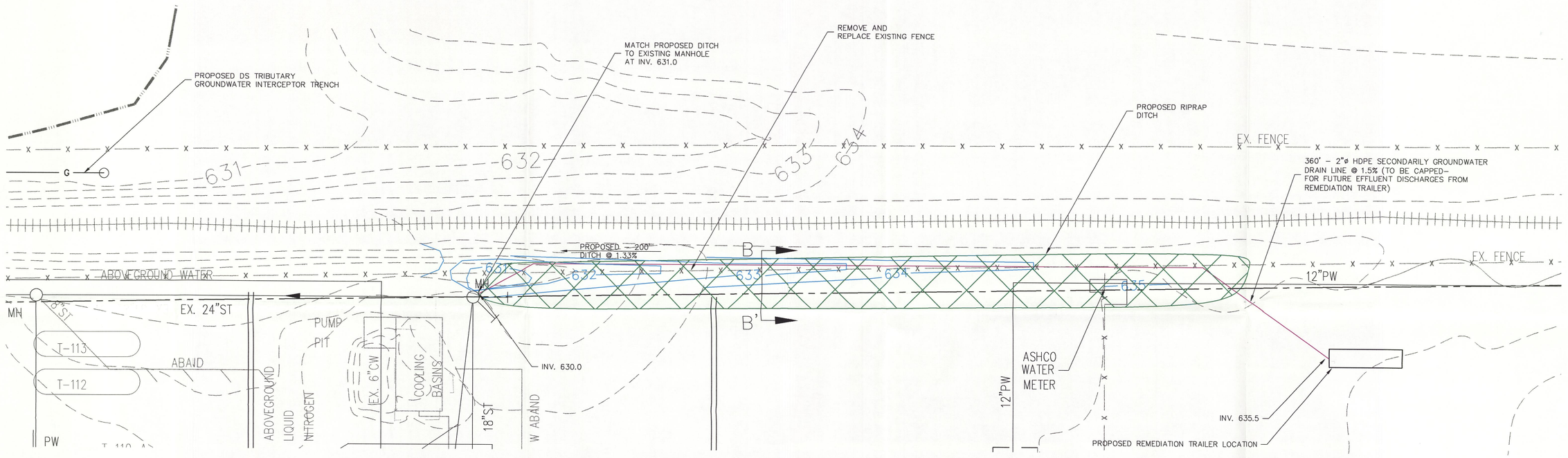
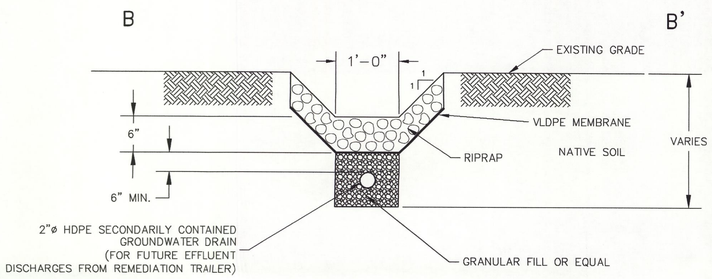




DITCH TYPICAL CROSS SECTION B–B'
NOT TO SCALE

LEGEND

- PROPOSED AREA FOR DITCH CLEANING AND REGRADING
- PROPOSED DRAIN LINE
- PROPOSED CONTOURS
- EXISTING CONTOURS

N

0 10 20 40
APPROXIMATE SCALE IN FEET

REV	DESCRIPTION OF REVISION	BY	DATE
0	REVISED 60 PERCENT DESIGN SUBMITTAL	MMS	6/2/99
1	REVISED FOR 90 PERCENT DESIGN SUBMITTAL	KMA	2/4/00

90 PERCENT DESIGN SUBMITTAL

URS Greiner Woodward Clyde
30775 Bainbridge Road, Suite 200
Solon, Ohio 44139

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

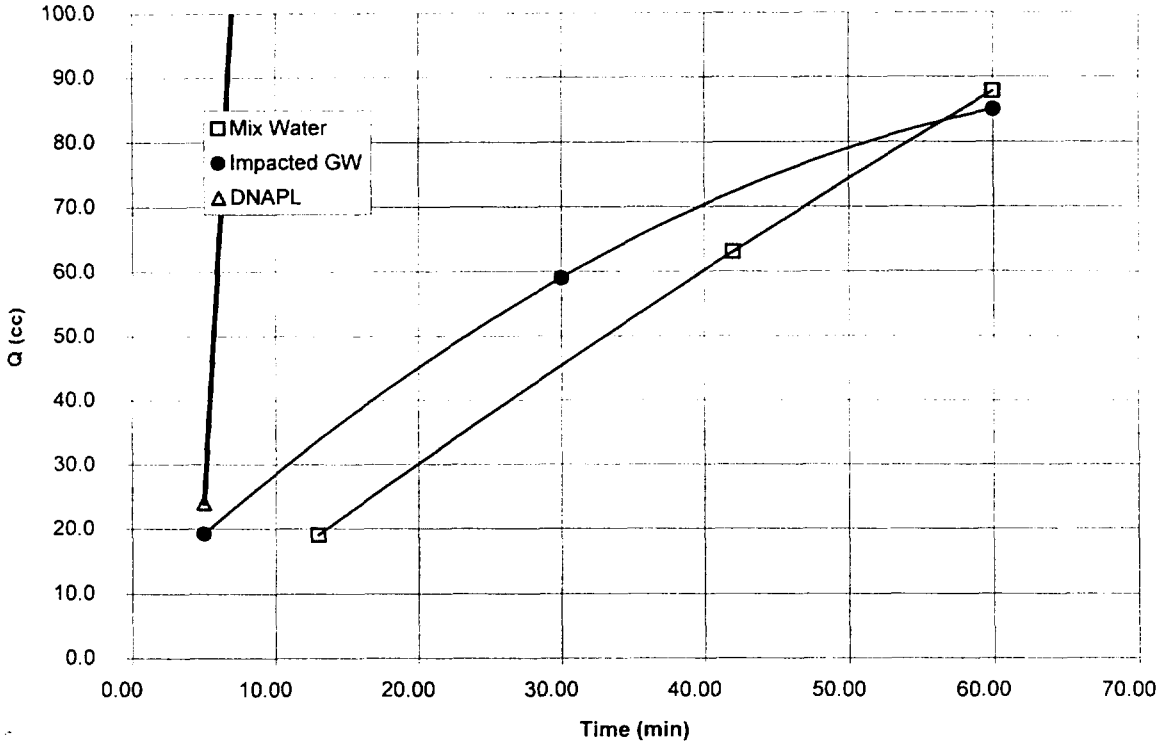
DESIGNED	DAS
DRAWN	GMZ
CHECKED	DAS
PEER REVIEWED	
PROJECT MANAGER	MLS
DATE	2–4–00

DNAPL RECOVERY SECONDARILY CONTAINED GROUNDWATER DRAIN LINE DETAIL

SOURCE CONTROL REMEDIAL COMPONENTS
DETREX CORPORATION FACILITY
ASHTABULA, OHIO

REVISION 1
PROJECT 38.8E06011.00
DRAWING **C-5D**

Filter Press Slurry Compatability Test
Slurry Mix 3: 6 % Attapulgite



mix water		Impacted GW		DNAPL	
Elapsed Time (min)	ΔQ (cc)	Elapsed Time (min)	ΔQ (cc)	Elapsed Time (min)	ΔQ (cc)
13.00	19.0	5.00	19.2	5.00	24.0
42.00	63.0	30.00	59.0	30.00	
60.00	87.8	60.00	85.0	60.00	

Cake Characteristics

Thickness (inch):	1/4"	9/32"	1/8"
Water Content (%):	301	288	160
Description:	Intact	loose	Intact (cracked)

Remarks: Rapid DNAPL breakthrough with subsequent free flow

Reviewed By: 12/21/99

Project No. 8E06011	DETREX SITE Design Tests	Effect of Permeant on Flow Rates with Attapulgite Slurry
URS GREINER WOODWARD CLYDE		

Sample	**Slurry Mix 1**							
Sample Area: A=	6.90 cm^2		Sample Height: L=	0.094 cm				
Date	**Time**	**Elapsed Time (min)**	**Pressure (psi)**	**ΔQ (cc)**	**Permeant**	**PV**	**ΔQ/Δt**	
########	13:20	6	100	3.2	tap water		0.533	
		10		4	tap water		0.400	0.2
		18		5.5	tap water		0.306	0.1875
		26		7.2	tap water		0.277	0.2
		31		8	tap water		0.258	0.194186
		47		10.8	tap water		0.230	0.172299
		65		13.8	tap water		0.212	0.170507
		90		18.2	tap water		0.202	0.172337
		122		23.4	tap water		0.192	0.16815
		131		25	tap water		0.191	0.164968
		150		28.5	tap water		0.190	0.182463
		184		34	tap water		0.185	0.168863
Vv=	-25.76822		Vc=	0.646875				
			Gs=	2.65				
			Wet initial=	210				
			Wo=	200				

Sample	Slurry Mix 1									
Sample Area: A=		0.00 cm^2	Sample Height: L=		0.094 cm					
Date	**Time**	**Elapsed Time**	**Pressure**	**ΔQ**	**Permeant**	**PV**	**ΔQ/Δt**	leachate/tap		
		(min)	**(psi)**	**(cc)**						
########	13:20	8	100	3.1	Leachate		0.388	0.727		
		10		3.6	Leachate		0.360	0.900	0.25	1.25
		18		5.4	Leachate		0.300	0.982	0.225	1.2
		27		7	Leachate		0.259	0.936	0.199539	0.997696
		32		8.2	Leachate		0.256	0.993	0.197351	1.016299
		47		12.2	Leachate		0.260	1.130	0.261538	1.517932
		65		16.8	Leachate		0.258	1.217	0.26044	1.527443
		90		23.7	Leachate		0.263	1.302	0.267977	1.554956
		95		25	Leachate		0.263	1.372	0.274194	1.630646
		121		31	Leachate		0.256	1.342	0.233935	1.418066
		150		39.8	Leachate		0.265	1.396	0.269749	1.478374
		184		48.9	Leachate		0.266	1.438	0.283657	1.679811

Attachment 4-B

Summary of Soil Additive Hydraulic Conductivity Tests

SUMMARY OF SOIL-ADDITIVE HYDRAULIC CONDUCTIVITY TESTING
PERMEANT COMPATABILITY TESTS

SOIL TYPE/ ADDITIVE TYPE	ADDITIVE ADDED DRY (By Dry Weight) (%)	TOTAL RATIO ADDITIVE: SOIL (By Dry Weight) (%)	WATER CONTENTS SETUP / PRE-TEST (%)	TOTAL UNIT WGTS. SETUP / PRE-TEST (pcf)	DRY UNIT WGTS. SETUP / PRE-TEST (pcf)	STRESSES EFFECTIVE / BACK PRESSURE (psi)	STAGE PERMEANT	PORE VOLUMES OF PERMEANT INITIAL / FINAL (-)	COEFFICIENT OF PERM. K, (@ 20 C) INITIAL / FINAL (cm/sec)	REMARKS
Soil Composite / Barakade 90	3.00	4.08	37.0	116.4	85.0	5.0	Mix W	0.00	5.75E-08	
			26.8	125.3	98.9	100.0		0.01	5.70E-08	
Soil Composite / Barakade 90	3.00	4.08	37.0	116.4	85.0	3.8	IMPACTED	0.01	6.39E-08	
			26.7	125.4	98.9	100.0	GROUNDWATER	5.50	5.27E-08	
Soil Composite / Barakade 90	3.00	4.12	40.2	114.3	81.6	10.0	Mix W	0.01	4.59E-08	
			28.4	123.8	96.4	100.0		0.01	4.50E-08	
Soil Composite / Barakade 90	3.00	4.08	40.2	114.3	81.6	8.3	DNAPL	0.04	2.15E-08	
			28.4	123.8	96.4	100.0		0.11	1.72E-09	Membrane failed
Soil Composite / SW 101	3.00	3.80	47.7	109.0	73.8	5.0	Mix W	0.00	4.29E-08	
			28.6	123.6	96.2	100.0		0.01	4.24E-08	
Soil Composite / SW 101	3.00	3.80	47.7	109.0	73.8	4.0	IMPACTED	0.02	3.85E-08	
			28.6	123.6	96.2	100.0	GROUNDWATER	4.30	2.95E-08	
Soil Composite / SW 101	3.00	3.82	49.4	108.8	72.8	8.0	Mix W	0.06	4.20E-08	
			32.8	119.9	90.3	100.0		0.43	4.01E-08	
Soil Composite / SW 101	3.00	3.82	49.4	108.8	72.8	7.9	DNAPL	0.17	3.54E-08	
			32.8	119.9	90.3	100.0		0.17	3.54E-08	Membrane failed
Soil Composite / Attapulgite	3.00	4.17	37.9	116.6	84.6	5.0	Mix W	0.00	8.62E-08	
			28.1	124.9	97.5	100.0		0.01	8.74E-08	
Soil Composite / Attapulgite	3.00	4.17	37.9	116.6	84.6	3.9	IMPACTED	0.01	1.00E-07	
			28.1	124.9	97.5	100.0	GROUNDWATER	7.39	1.20E-07	
Soil Composite / Attapulgite	3.00	4.27	40.8	114.3	81.2	10.0	Mix W	0.01	7.20E-08	
			28.5	124.4	96.8	100.0		0.02	7.23E-08	
Soil Composite / Attapulgite	3.00	4.27	40.8	114.3	81.2	8.3	DNAPL	0.07	7.43E-08	
			28.5	124.4	96.8	100.0		0.23	4.32E-09	Membrane failed

Reviewed by: _____ Date: 12/21/1999

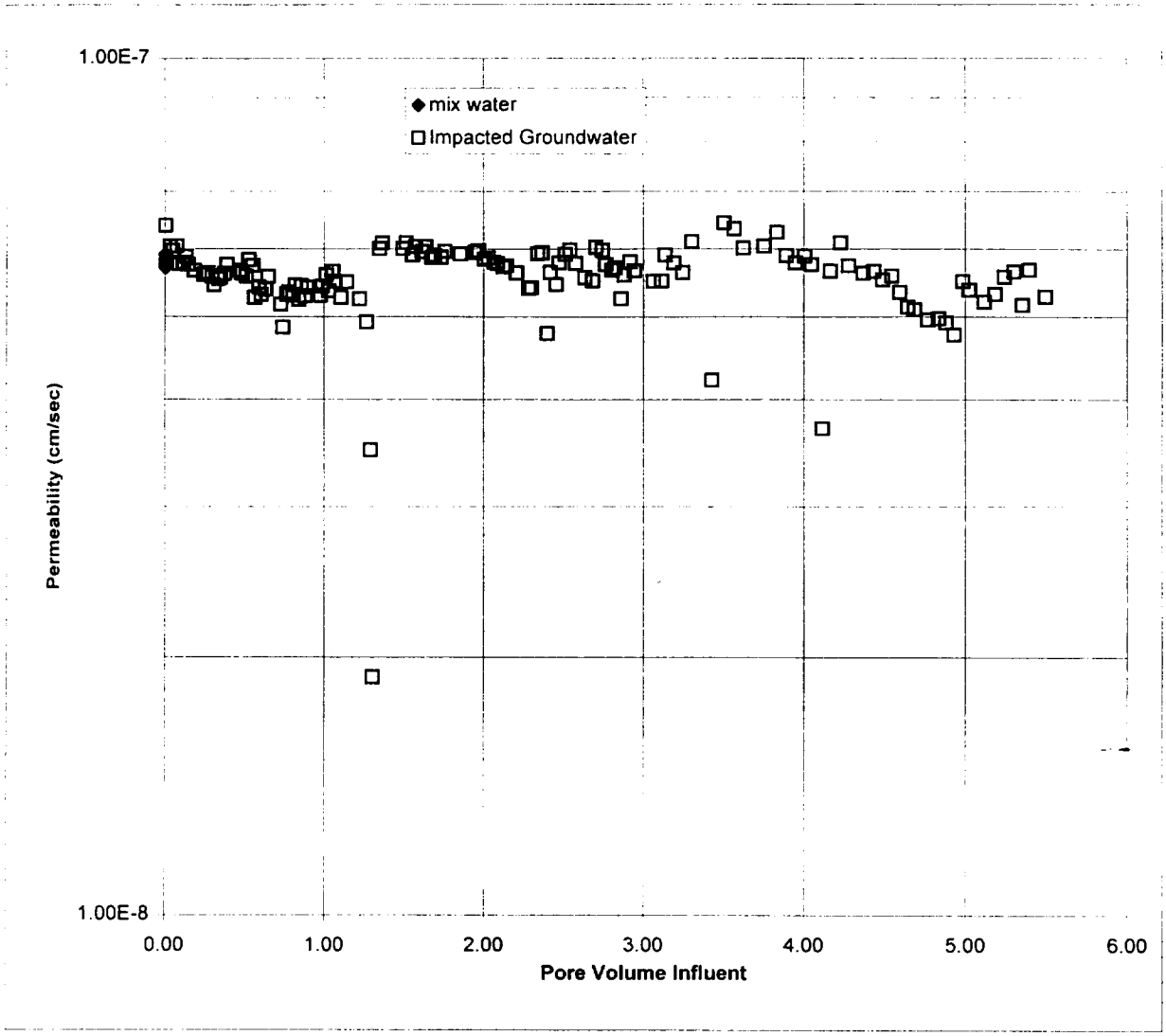
SUMMARY OF SOIL-ADDITIVE HYDRAULIC CONDUCTIVITY TESTING
PERMEANT COMPATABILITY TESTS

SOIL TYPE/ ADDITIVE TYPE	ADDITIVE ADDED DRY (By Dry Weight) (%)	TOTAL RATIO ADDITIVE: SOIL (By Dry Weight) (%)	WATER CONTENTS SETUP PRE-TEST (%)	TOTAL UNIT WGTS. SETUP PRE-TEST (pcf)	DRY UNIT WGTS. SETUP PRE-TEST (pcf)	STRESSES EFFECTIVE BACK PRESSURE (psi)	STAGE PERMEANT	PORE VOLUMES OF PERMEANT INITIAL FINAL (-)	COEFFICIENT OF PERM. K, (@ 20 C) INITIAL FINAL (cm/sec)	REMARKS

Notes: Pre-test is at the start of permeation.

Project No. 38-08E06011
Project Name: Detrex
Boring No. Composite
Sample No. Barakade 90
+3% dry

Test No.: P5327.xls



PERMEABILITY TEST SUMMARY
ASTM D5084

Project No. 38-08E06011
Project Name: Detrex
Boring No. Composite
Sample No. Barakade 90
+3% dry

Test No.: Compsum1.
Volume Voids 105.7 cm^3

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
1	Tap	19.5	03/11/1999	0.1	0.1	0.0	0.1	0.1	0.0	6.84E-8
2	Tap	20.2	03/11/1999	0.1	0.3	0.0	0.1	0.3	0.0	6.37E-8
3	Tap	20.3	03/11/1999	0.2	0.5	0.0	0.2	0.5	0.0	6.28E-8
4	Tap	20.3	03/11/1999	0.2	0.6	0.0	0.2	0.6	0.0	6.22E-8
5	Tap	20.4	03/11/1999	0.2	0.8	0.0	0.2	0.8	0.0	6.23E-8
1	Mix W	21.0	03/12/1999	0.2	0.2	0.0	0.2	0.2	0.0	5.75E-8
2	Mix W	20.4	03/12/1999	0.1	0.3	0.0	0.1	0.3	0.0	5.83E-8
3	Mix W	20.4	03/12/1999	0.2	0.5	0.0	0.2	0.5	0.0	5.91E-8
4	Mix W	20.0	03/12/1999	0.1	0.6	0.0	0.1	0.6	0.0	5.70E-8
1	Impacted GW	24.7	03/15/1999	0.6	0.6	0.0	0.5	0.5	0.1	6.39E-8
2	Impacted GW	24.1	03/15/1999	3.1	3.7	0.0	3.0	3.5	0.2	6.04E-8
3	Impacted GW	24.0	03/16/1999	1.6	5.2	0.0	1.6	5.1	0.2	5.97E-8
4	Impacted GW	23.9	03/16/1999	2.9	8.2	0.1	2.9	8.0	0.2	6.04E-8
5	Impacted GW	23.9	03/17/1999	1.5	9.7	0.1	1.5	9.5	0.2	5.76E-8
6	Impacted GW	24.0	03/17/1999	2.8	12.5	0.1	2.8	12.3	0.3	5.78E-8
7	Impacted GW	23.9	03/18/1999	1.8	14.3	0.1	1.8	14.1	0.3	5.88E-8
8	Impacted GW	23.9	03/19/1999	1.6	15.9	0.2	1.6	15.6	0.3	5.75E-8
9	Impacted GW	23.9	03/19/1999	4.0	19.9	0.2	4.0	19.6	0.3	5.66E-8
10	Impacted GW	24.0	03/20/1999	6.1	26.0	0.2	6.1	25.7	0.4	5.59E-8
11	Impacted GW	23.9	03/22/1999	1.4	27.5	0.3	1.4	27.1	0.3	5.59E-8
12	Impacted GW	23.9	03/23/1999	1.5	29.0	0.3	1.5	28.6	0.3	5.62E-8
13	Impacted GW	24.1	03/23/1999	2.7	31.7	0.3	2.7	31.3	0.3	5.57E-8
14	Impacted GW	23.9	03/24/1999	1.4	33.1	0.3	1.4	32.8	0.3	5.44E-8
15	Impacted GW	24.0	03/24/1999	2.8	35.8	0.3	2.7	35.5	0.3	5.53E-8
16	Impacted GW	23.9	03/25/1999	1.4	37.2	0.4	1.4	36.9	0.3	5.55E-8
17	Impacted GW	23.5	03/25/1999	2.8	40.0	0.4	2.7	39.6	0.3	5.61E-8
18	Impacted GW	23.9	03/26/1999	1.6	41.6	0.4	1.7	41.4	0.2	5.75E-8
19	Impacted GW	23.0	03/26/1999	8.5	50.0	0.5	8.3	49.7	0.3	5.66E-8
20	Impacted GW	22.9	03/29/1999	1.4	51.4	0.5	1.6	51.3	0.2	5.62E-8
21	Impacted GW	25.1	03/29/1999	2.9	54.3	0.5	2.8	54.0	0.3	5.57E-8
22	Impacted GW	23.9	03/30/1999	1.8	56.1	0.5	1.8	55.8	0.3	5.82E-8
23	Impacted GW	22.8	03/30/1999	2.4	58.5	0.6	2.4	58.3	0.3	5.73E-8
24	Impacted GW	23.4	03/31/1999	1.5	60.0	0.6	1.7	59.9	0.1	5.26E-8
25	Impacted GW	25.1	03/31/1999	2.9	62.9	0.6	2.7	62.6	0.3	5.41E-8
26	Impacted GW	23.9	04/01/1999	1.4	64.2	0.6	1.5	64.1	0.1	5.30E-8
27	Impacted GW	24.6	04/01/1999	2.8	67.1	0.6	2.8	66.9	0.2	5.38E-8
28	Impacted GW	24.0	04/02/1999	1.8	68.9	0.7	1.9	68.8	0.1	5.57E-8
29	Impacted GW	24.0	04/02/1999	8.2	77.1	0.7	8.0	76.8	0.3	5.17E-8
30	Impacted GW	23.8	04/05/1999	1.6	78.7	0.7	1.7	78.5	0.2	4.86E-8
31	Impacted GW	24.0	04/05/1999	2.5	81.2	0.8	2.4	80.9	0.3	5.31E-8
32	Impacted GW	24.1	04/06/1999	1.6	82.7	0.8	1.7	82.5	0.2	5.34E-8

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
33	Impacted GW	24.0	04/06/1999	2.5	85.2	0.8	2.4	84.9	0.3	5.30E-8
34	Impacted GW	24.0	04/07/1999	1.8	87.0	0.8	1.8	86.7	0.3	5.44E-8
35	Impacted GW	24.1	04/07/1999	2.1	89.1	0.8	2.1	88.8	0.3	5.23E-8
36	Impacted GW	24.0	04/08/1999	1.7	90.8	0.9	1.7	90.5	0.3	5.43E-8
37	Impacted GW	24.1	04/08/1999	2.3	93.1	0.9	2.3	92.9	0.3	5.29E-8
38	Impacted GW	24.1	04/09/1999	1.7	94.8	0.9	1.7	94.5	0.3	5.41E-8
39	Impacted GW	24.1	04/09/1999	8.5	103.3	1.0	8.4	103.0	0.3	5.29E-8
40	Impacted GW	24.0	04/12/1999	1.4	104.7	1.0	1.5	104.5	0.2	5.42E-8
41	Impacted GW	24.1	04/12/1999	2.7	107.4	1.0	2.7	107.2	0.2	5.59E-8
42	Impacted GW	24.1	04/13/1999	1.5	108.9	1.0	1.5	108.7	0.2	5.36E-8
43	Impacted GW	24.1	04/13/1999	2.7	111.6	1.1	2.6	111.3	0.2	5.65E-8
44	Impacted GW	24.0	04/14/1999	1.6	113.1	1.1	1.6	112.9	0.2	5.50E-8
45	Impacted GW	24.0	04/14/1999	3.9	117.0	1.1	3.9	116.8	0.2	5.26E-8
46	Impacted GW	24.0	04/15/1999	3.9	121.0	1.1	3.9	120.7	0.3	5.49E-8
47	Impacted GW	24.0	04/16/1999	8.5	129.5	1.2	8.4	129.1	0.4	5.24E-8
48	Impacted GW	24.0	04/19/1999	4.5	134.0	1.3	4.6	133.7	0.3	4.93E-8
49	Impacted GW	24.1	04/20/1999	2.6	136.6	1.3	2.8	136.4	0.2	3.49E-8
50	Impacted GW	24.0	04/21/1999	1.3	137.9	1.3	1.3	137.8	0.1	1.90E-8
51	Impacted GW	34.3	04/22/1999	4.6	142.5	1.3	4.6	142.3	0.2	6.00E-8
52	Impacted GW	34.6	04/23/1999	1.8	144.3	1.4	1.8	144.2	0.2	6.09E-8
53	Impacted GW	34.8	04/23/1999	13.6	158.0	1.5	13.6	157.8	0.2	6.00E-8
54	Impacted GW	34.7	04/26/1999	2.3	160.2	1.5	2.3	160.1	0.1	6.10E-8
55	Impacted GW	34.8	04/26/1999	4.1	164.4	1.6	4.1	164.3	0.1	5.90E-8
56	Impacted GW	34.6	04/27/1999	2.2	166.6	1.6	2.2	166.5	0.1	6.03E-8
57	Impacted GW	34.7	04/27/1999	4.2	170.8	1.6	4.2	170.6	0.1	5.95E-8
58	Impacted GW	34.7	04/28/1999	2.5	173.2	1.6	2.4	173.1	0.1	6.04E-8
59	Impacted GW	34.7	04/28/1999	3.9	177.2	1.7	3.9	177.0	0.2	5.86E-8
60	Impacted GW	34.7	04/29/1999	2.0	179.1	1.7	2.0	179.0	0.2	5.90E-8
61	Impacted GW	34.7	04/29/1999	4.4	183.5	1.7	4.3	183.3	0.2	5.86E-8
62	Impacted GW	34.7	04/30/1999	2.4	185.9	1.8	2.4	185.7	0.2	5.95E-8
63	Impacted GW	34.6	04/30/1999	10.4	196.4	1.9	10.3	196.0	0.3	5.91E-8
64	Impacted GW	34.5	05/02/1999	9.5	205.9	1.9	9.5	205.5	0.4	5.94E-8
65	Impacted GW	34.6	05/04/1999	2.3	208.2	2.0	2.3	207.9	0.3	5.97E-8
66	Impacted GW	34.8	05/04/1999	4.0	212.1	2.0	3.9	211.8	0.3	5.83E-8
67	Impacted GW	34.6	05/05/1999	2.5	214.6	2.0	2.5	214.3	0.3	5.85E-8
68	Impacted GW	34.7	05/05/1999	3.8	218.4	2.1	3.8	218.1	0.3	5.79E-8
69	Impacted GW	34.6	05/06/1999	2.3	220.7	2.1	2.3	220.4	0.3	5.76E-8
70	Impacted GW	34.7	05/06/1999	3.9	224.6	2.1	3.9	224.3	0.3	5.71E-8
71	Impacted GW	34.7	05/07/1999	2.2	226.8	2.1	2.2	226.5	0.3	5.73E-8
72	Impacted GW	34.8	05/07/1999	6.5	233.4	2.2	6.5	233.0	0.3	5.62E-8
73	Impacted GW	34.7	05/08/1999	8.0	241.4	2.3	7.8	240.8	0.5	5.39E-8
74	Impacted GW	34.7	05/10/1999	1.9	243.3	2.3	1.9	242.7	0.5	5.40E-8
75	Impacted GW	34.7	05/10/1999	4.3	247.6	2.3	4.2	246.9	0.7	5.92E-8
76	Impacted GW	34.7	05/11/1999	2.7	250.3	2.4	2.7	249.6	0.8	5.93E-8
77	Impacted GW	34.7	05/11/1999	3.4	253.7	2.4	3.4	252.9	0.8	4.78E-8
78	Impacted GW	34.7	05/12/1999	2.1	255.8	2.4	2.0	255.0	0.9	5.63E-8
79	Impacted GW	34.7	05/12/1999	3.8	259.7	2.5	3.9	258.9	0.8	5.45E-8
80	Impacted GW	34.7	05/13/1999	2.0	261.6	2.5	2.0	260.9	0.8	5.78E-8
81	Impacted GW	34.7	05/13/1999	4.1	265.7	2.5	4.1	264.9	0.8	5.91E-8

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
82	Impacted GW	34.6	05/14/1999	3.0	268.7	2.5	2.9	267.8	0.8	5.98E-8
83	Impacted GW	34.7	05/14/1999	4.0	272.6	2.6	3.9	271.7	0.9	5.77E-8
84	Impacted GW	34.5	05/15/1999	6.0	278.7	2.6	5.8	277.6	1.1	5.55E-8
85	Impacted GW	34.3	05/16/1999	5.1	283.7	2.7	5.0	282.5	1.2	5.50E-8
86	Impacted GW	34.7	05/17/1999	2.3	286.1	2.7	2.3	284.8	1.3	6.03E-8
87	Impacted GW	34.7	05/17/1999	4.2	290.2	2.7	4.0	288.8	1.4	5.97E-8
88	Impacted GW	34.5	05/18/1999	2.3	292.5	2.8	2.2	291.0	1.5	5.75E-8
89	Impacted GW	34.7	05/18/1999	4.0	296.6	2.8	3.9	294.9	1.6	5.66E-8
90	Impacted GW	34.7	05/19/1999	2.0	298.5	2.8	2.0	296.9	1.6	5.70E-8
91	Impacted GW	34.8	05/19/1999	3.8	302.3	2.9	3.8	300.7	1.7	5.25E-8
92	Impacted GW	34.7	05/20/1999	2.2	304.5	2.9	2.2	302.8	1.7	5.59E-8
93	Impacted GW	34.7	05/20/1999	4.0	308.5	2.9	4.0	306.8	1.7	5.79E-8
94	Impacted GW	34.8	05/21/1999	2.5	311.0	2.9	2.3	309.2	1.9	5.65E-8
95	Impacted GW	34.8	05/21/1999	12.7	323.7	3.1	12.5	321.6	2.1	5.50E-8
96	Impacted GW	34.8	05/24/1999	5.4	329.2	3.1	5.5	327.2	2.0	5.50E-8
97	Impacted GW	34.7	05/25/1999	2.3	331.5	3.1	2.3	329.5	2.0	5.90E-8
98	Impacted GW	34.7	05/25/1999	5.8	337.3	3.2	5.8	335.3	2.0	5.78E-8
99	Impacted GW	34.7	05/26/1999	5.9	343.2	3.2	5.9	341.2	2.0	5.62E-8
100	Impacted GW	34.7	05/27/1999	6.0	349.2	3.3	5.9	347.1	2.0	6.11E-8
101	Impacted GW	34.7	05/28/1999	13.2	362.3	3.4	13.1	360.2	2.1	4.22E-8
102	Impacted GW	34.6	06/01/1999	8.1	370.5	3.5	8.1	368.3	2.2	6.43E-8
103	Impacted GW	34.6	06/02/1999	6.7	377.2	3.6	6.7	375.0	2.2	6.33E-8
104	Impacted GW	34.7	06/03/1999	6.1	383.3	3.6	6.0	381.0	2.2	6.01E-8
105	Impacted GW	34.8	06/04/1999	13.6	396.8	3.8	13.5	394.5	2.3	6.04E-8
106	Impacted GW	34.7	06/07/1999	8.4	405.2	3.8	8.4	402.9	2.3	6.27E-8
107	Impacted GW	34.7	06/08/1999	6.1	411.4	3.9	6.0	409.0	2.4	5.89E-8
108	Impacted GW	34.6	06/09/1999	6.0	417.3	3.9	5.9	414.9	2.4	5.77E-8
109	Impacted GW	34.7	06/10/1999	5.9	423.2	4.0	5.9	420.8	2.5	5.89E-8
110	Impacted GW	34.7	06/11/1999	4.5	427.7	4.0	4.5	425.3	2.5	5.75E-8
111	Impacted GW	34.8	06/12/1999	7.0	434.8	4.1	7.0	432.3	2.5	3.70E-8
113	Impacted GW	34.7	06/15/1999	5.4	440.2	4.2	5.2	437.5	2.7	5.65E-8
114	Impacted GW	34.7	06/16/1999	6.6	446.8	4.2	6.5	444.0	2.8	6.10E-8
115	Impacted GW	34.6	06/17/1999	5.2	452.0	4.3	5.2	449.2	2.8	5.73E-8
116	Impacted GW	34.8	06/18/1999	9.8	461.7	4.4	9.7	458.9	2.9	5.62E-8
117	Impacted GW	34.5	06/20/1999	7.0	468.8	4.4	7.0	465.9	2.9	5.65E-8
118	Impacted GW	34.7	06/21/1999	5.7	474.4	4.5	5.7	471.6	2.9	5.52E-8
119	Impacted GW	34.6	06/22/1999	6.0	480.4	4.5	6.0	477.5	2.9	5.58E-8
120	Impacted GW	34.7	06/23/1999	5.3	485.8	4.6	5.3	482.9	2.9	5.33E-8
121	Impacted GW	34.7	06/24/1999	5.3	491.0	4.6	5.2	488.1	2.9	5.13E-8
122	Impacted GW	34.7	06/25/1999	4.3	495.3	4.7	4.2	492.3	3.0	5.09E-8
123	Impacted GW	34.7	06/26/1999	8.9	504.2	4.8	8.8	501.1	3.1	4.96E-8
124	Impacted GW	34.7	06/28/1999	6.9	511.1	4.8	6.9	508.0	3.1	4.97E-8
125	Impacted GW	34.7	06/29/1999	4.9	516.0	4.9	4.8	512.8	3.2	4.92E-8
126	Impacted GW	34.7	06/30/1999	5.3	521.3	4.9	5.3	518.1	3.2	4.76E-8
127	Impacted GW	34.7	07/01/1999	5.6	527.0	5.0	5.6	523.8	3.2	5.49E-8
128	Impacted GW	34.8	07/02/1999	4.3	531.2	5.0	4.2	528.0	3.2	5.37E-8
129	Impacted GW	34.8	07/03/1999	9.8	541.1	5.1	9.7	537.8	3.3	5.20E-8
130	Impacted GW	34.3	07/05/1999	7.0	548.1	5.2	7.4	545.2	2.9	5.31E-8
131	Impacted GW	34.6	07/06/1999	6.1	554.2	5.2	6.0	551.1	3.1	5.56E-8

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
132	Impacted GW	34.8	07/07/1999	6.3	560.5	5.3	6.1	557.2	3.3	5.64E-8
133	Impacted GW	34.6	07/08/1999	5.3	565.8	5.4	5.3	562.5	3.3	5.16E-8
134	Impacted GW	34.9	07/09/1999	4.5	570.3	5.4	4.4	567.0	3.3	5.67E-8
135	Impacted GW	34.5	07/10/1999	10.5	580.9	5.5	10.6	577.6	3.3	5.27E-8

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 SAMPLE: Composite Test No.: P5327

Project Name: Detrex BENTONITE: PERCENT: +3% dry

Specimen - Apparatus set-up - Test Information Cell No. H-4 Apparatus No. 1 Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.695	in	Lo=	6.845	cm
dLc=	0.086	in	Ao =	42.40	cm2
Lc=	2.609	in	Vo =	290.23	cm3
			Lc=	6.627	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	27.78	cm3
			Vc =	262.45	cm3
Sc =	0.167	cm-1	Ac=	39.604	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes		
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation		
6) Permeant: water used		Tap		Distilled		
or Mix		Demineralized		0.005 N calcium sulfate (CaSO4)		

Equations Used

Kt = - 0.0000760 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.319

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.627	cm	ξιαλ =	3.2%	
Ac =	37.653	cm2			
Vc=	249.52	cm3	εϖολ =	14.0%	
Sc =	0.176	cm-1	Sc = Lc / Ac , final		

	w (%)	γτ (pcf)	γδ (pcf)	S (%)
Initial	36.99	116.4	85.0	99.7
PreTest	26.79	125.3	98.9	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **5.80E-08** cm/sec

(io)ave = 20.5

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	Time min	Time sec	Initial sc psi	Initial Ub psi	U-tube Reading Head (cm) (cc)	U-tube Reading Tail (cm) (cc)	Flow in/out gradient	Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.5	03/12/1999	09	25	00	105.0	100.0	53.20	42.11	0.98	5.65E-08
final	21.5	03/12/1999	10	30	00			51.09	42.80		5.75E-08
1	RT = 0.968	dT =		65.00 min		s'c =	0.7 ksf	0.160	0.164	io= 21.0	-1%
initial	21.5	03/12/1999	10	33	00	105.0	100.0	52.96	42.20	0.98	5.73E-08
final	21.5	03/12/1999	11	28	00			51.17	42.78		5.83E-08
2	RT = 0.968	dT =		55.00 min		s'c =	0.7 ksf	0.135	0.137	io= 20.4	1%
initial	21.5	03/12/1999	11	31	00	105.0	100.0	52.95	42.20	1.02	5.80E-08
final	21.4	03/12/1999	12	43	00			50.67	42.91		5.91E-08
3	RT = 0.969	dT =		72.00 min		s'c =	0.7 ksf	0.172	0.168	io= 20.4	2%
initial	21.4	03/12/1999	12	48	00	105.0	100.0	52.80	42.25	1.04	5.59E-08
final	21.4	03/12/1999	13	46	00			51.00	42.80		5.70E-08
4	RT = 0.970	dT =		58.00 min		s'c =	0.7 ksf	0.136	0.130	io= 20.0	-2%
								0.000	0.000		

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for	x	Vertical or		Horizontal permeability determination		
5) Direction of permeant :	x	Up during or		Down during permeation		
3) During saturation Water flushed up sides of specimen to remove air			x	No		Yes
4) During consolidation	x	Top and bottom drainage or		Top		Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or 0.005 N calcium sulfate (CaSO4)

Cell No.	H-4									
Stage No.	4	sc	105.0	psi	System:	p=pipette	a = annulus	b =both		
Apparatus No.	5	Ub	100.0	psi	Head Tube Area =	0.2335	0.0000	0.0000	cm2	cm2
(s'c)max=	5.0 psi	(s'c)min=	2.7 psi	'c)av=	3.8 psi	Tail Tube Area =	0.2335	0.0000	0.0000	cm2	cm2

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial No	Stage	Temp. °C	Time Day	hour	minute	second	Pressure Head Reading Mercury (inch)	Gage (psi)	Fluid Head Reading Head (cm)/cc	Tail (cm)/cc	Burette Flow Ratio in/out	Total Head (cm H2O) gradient	Permeability (cm/sec) Preliminary Final at 20°C Dev. from Ave
1	I	21.5	03/15/1999	14	8	0		1.00	96.10	8.25	p	163.73	6.27E-08
	F	21.5	03/15/1999	16	36	0		1.15	93.60	10.35	p	159.13	6.39E-08
		Rt= 0.968	dT =	148.00 min				1.08	0.58 cc	0.49 cc	1.19	io =24.7	7%
2	I	21.5	03/15/1999	16	44	0		1.00	96.15	7.35	p	159.38	5.93E-08
	F	21.5	03/16/1999	9	4	0		1.00	82.95	20.20	p	133.33	6.04E-08
		Rt= 0.968	dT =	980.00 min				1.00	3.08 cc	3.00 cc	1.03	io =24.1	1%
3	I	21.5	03/16/1999	9	9	0		1.00	95.95	7.80	p	158.73	5.86E-08
	F	21.5	03/16/1999	17	21	0		1.00	89.20	14.50	p	145.28	5.97E-08
		Rt= 0.968	dT =	492.00 min				1.00	1.58 cc	1.56 cc	1.01	io =24.0	0%
4	I	21.5	03/16/1999	17	27	0		1.00	96.10	8.40	p	158.28	5.94E-08
	F	21.6	03/17/1999	9	5	0		1.00	83.60	20.80	p	133.38	6.04E-08
		Rt= 0.967	dT =	938.00 min				1.00	2.92 cc	2.90 cc	1.01	io =23.9	2%
5	I	21.6	03/17/1999	9	13	0		1.00	96.00	7.90	p	158.68	5.70E-08
	F	22.1	03/17/1999	17	23	0		1.00	89.50	14.45	p	145.63	5.76E-08
		Rt= 0.959	dT =	490.00 min				1.00	1.52 cc	1.53 cc	0.99	io =23.9	-3%
6	I	22.1	03/17/1999	17	29	0		1.00	96.10	7.60	p	159.08	5.73E-08
	F	21.7	03/18/1999	9	4	0		1.00	83.90	19.55	p	134.93	5.78E-08
		Rt= 0.958	dT =	935.00 min				1.00	2.85 cc	2.79 cc	1.02	io =24.0	-3%
7	I	21.7	03/18/1999	9	8	0		1.00	96.10	8.35	p	158.33	5.78E-08
	F	21.5	03/18/1999	18	44	0		1.00	88.40	16.05	p	142.93	5.88E-08
		Rt= 0.965	dT =	576.00 min				1.00	1.80 cc	1.80 cc	1.00	io =23.9	-1%
8	I	21.5	03/19/1999	9	3	0		1.00	95.85	8.10	p	158.33	5.62E-08
	F	21.2	03/19/1999	17	31	0		1.00	89.20	14.75	p	145.03	5.75E-08
		Rt= 0.971	dT =	508.00 min				1.00	1.55 cc	1.55 cc	1.00	io =23.9	-3%
9	I	21.2	03/19/1999	17	37	0		1.00	96.15	8.05	p	158.68	5.51E-08
	F	21.2	03/20/1999	17	40	0		1.00	78.90	25.20	p	124.28	5.66E-08
		Rt= 0.975	dT =	1443.00 min				1.00	4.03 cc	4.00 cc	1.01	io =23.9	-5%
10	I	21.2	03/20/1999	17	43	0		1.00	96.30	7.80	p	159.08	5.48E-08
	F	21.6	03/22/1999	9	13	0		1.00	70.00	33.80	p	106.78	5.59E-08
		Rt= 0.970	dT =	2370.00 min				1.00	6.14 cc	6.07 cc	1.01	io =24.0	-6%
11	I	21.6	03/22/1999	9	18	0		1.00	96.15	8.30	p	158.43	5.49E-08
	F	21.4	03/22/1999	17	13	0		1.00	90.10	14.45	p	146.23	5.59E-08
		Rt= 0.968	dT =	475.00 min				1.00	1.41 cc	1.44 cc	0.98	io =23.9	-6%
12	I	21.6	03/23/1999	9	11	0		1.00	95.90	7.90	p	158.58	5.51E-08
	F	21.3	03/23/1999	17	30	0		1.00	89.50	14.35	p	145.73	5.62E-08
		Rt= 0.969	dT =	499.00 min				1.00	1.49 cc	1.51 cc	0.99	io =23.9	-6%
13	I	21.3	03/23/1999	17	32	0		1.00	96.10	7.00	p	159.68	5.45E-08
	F	21.4	03/24/1999	9	8	0		1.00	84.55	18.60	p	136.53	5.57E-08
		Rt= 0.971	dT =	936.00 min				1.00	2.70 cc	2.71 cc	1.00	io =24.1	-6%
14	I	21.4	03/24/1999	9	11	0		1.00	96.00	7.95	p	158.63	5.41E-08

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.627	cm	ε_{axial} =
Ac =	37.631	cm2	
Vc=	249.37	cm3	ε_{vol} =

	w (%)	γ_t (pcf)	γ_d (pcf)
Initial	36.99	116.4	85.0
PreTest	26.75	125.4	98.9

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials:	2-5	
ave K @ 20 °C:	**5.95E-08**	cm/sec
(io)ave =	23.96	

Tested By: Reviewed By:

SAMPLE: Composite
BENTONITE: Barakade 90
Project No. 38-08E06011
Project Name: Detrex

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or				
	x	with stones or		Stones with filter paper or		top + bottom		
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination				
5) Direction of permeant :	x	Up during or		Down during permeation				
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes		
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only		
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)

Cell No.	H-4									
Stage No.	4	sc	105.0	psi	System: p=pipette a = annulus b =both					
Apparatus No.	5	Ub	100.0	psi	Head Tube Area =	0.2335	0.0000	0.0000	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.7 psi	'c)av= 3.8 psi			Tail Tube Area =	0.2335	0.0000	0.0000	cm2	cm2

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary	Permeability (cm/sec) Final at 20°C
29	I	23.2	04/02/1999	19	14	0		1.00	96.45	8.00	p	159.03	5.17E-08	
	F	21.3	04/05/1999	7	11	0		1.00	61.45	42.20	p	89.83	5.17E-08	
		Rt= 0.949	dT =	3597.00 min				1.00	8.17 cc	7.99 cc	1.02	io =24.0	-13%	
30	I	21.3	04/05/1999	8	26	0		1.00	96.15	8.75	p	157.98	4.90E-08	
	F	23.8	04/05/1999	18	38	0		1.00	89.50	16.00	p	144.08	4.86E-08	
		Rt= 0.942	dT =	612.00 min				1.00	1.55 cc	1.69 cc	0.92	io =23.8	-18%	
31	I	23.8	04/05/1999	18	46	0		1.00	96.25	8.10	p	158.73	5.37E-08	
	F	21.6	04/06/1999	9	6	0		1.00	85.50	18.35	p	137.73	5.31E-08	
		Rt= 0.938	dT =	860.00 min				1.00	2.51 cc	2.39 cc	1.05	io =24.0	-11%	
32	I	21.6	04/06/1999	9	12	0		1.00	96.20	7.30	p	159.48	5.31E-08	
	F	22.4	04/06/1999	18	29	0		1.00	89.55	14.50	p	145.63	5.34E-08	
		Rt= 0.956	dT =	557.00 min				1.00	1.55 cc	1.68 cc	0.92	io =24.1	-10%	
33	I	22.4	04/06/1999	18	36	0		1.00	96.25	8.00	p	158.83	5.31E-08	
	F	22.2	04/07/1999	9	8	0		1.00	85.45	18.25	p	137.78	5.30E-08	
		Rt= 0.948	dT =	872.00 min				1.00	2.52 cc	2.39 cc	1.05	io =24.0	-11%	
34	I	22.2	04/07/1999	9	12	0		1.00	96.25	7.90	p	158.93	5.35E-08	
	F	21.0	04/07/1999	19	19	0		1.00	88.75	15.50	p	143.83	5.44E-08	
		Rt= 0.965	dT =	607.00 min				1.00	1.75 cc	1.77 cc	0.99	io =24.0	-9%	
35	I	21.0	04/07/1999	19	22	0		1.00	96.20	7.35	p	159.43	5.12E-08	
	F	21.7	04/08/1999	8	11	0		1.00	87.10	16.40	p	141.28	5.23E-08	
		Rt= 0.971	dT =	769.00 min				1.00	2.12 cc	2.11 cc	1.01	io =24.1	-12%	
36	I	21.7	04/08/1999	8	16	0		1.00	96.20	7.55	p	159.23	5.32E-08	
	F	21.1	04/08/1999	18	9	0		1.00	88.85	14.90	p	144.53	5.43E-08	
		Rt= 0.970	dT =	593.00 min				1.00	1.72 cc	1.72 cc	1.00	io =24.0	-9%	
37	I	21.1	04/08/1999	18	15	0		1.00	96.30	7.35	p	159.53	5.16E-08	
	F	21.5	04/09/1999	8	13	0		1.00	86.40	17.30	p	139.68	5.29E-08	
		Rt= 0.973	dT =	838.00 min				1.00	2.31 cc	2.32 cc	0.99	io =24.1	-11%	
38	I	21.5	04/09/1999	8	18	0		1.00	96.45	7.40	p	159.63	5.30E-08	
	F	21.4	04/09/1999	17	52	0		1.00	89.35	14.55	p	145.38	5.41E-08	
		Rt= 0.969	dT =	574.00 min				1.00	1.66 cc	1.67 cc	0.99	io =24.1	-9%	
39	I	21.4	04/09/1999	17	57	0		1.00	96.20	7.15	p	159.63	5.16E-08	
	F	21.0	04/12/1999	9	35	0		1.00	59.90	43.30	p	87.18	5.29E-08	
		Rt= 0.975	dT =	3818.00 min				1.00	8.48 cc	8.44 cc	1.00	io =24.1	-11%	
40	I	21.0	04/12/1999	9	43	0		1.00	96.30	8.15	p	158.73	5.36E-08	
	F	22.5	04/12/1999	18	14	0		1.00	90.10	14.75	p	145.93	5.42E-08	
		Rt= 0.962	dT =	511.00 min				1.00	1.45 cc	1.54 cc	0.94	io =24.0	-9%	
41	I	22.5	04/12/1999	18	18	0		1.00	96.30	7.50	p	159.38	5.54E-08	
	F	21.2	04/13/1999	9	28	0		1.00	84.80	18.85	p	136.53	5.59E-08	
		Rt= 0.959	dT =	910.00 min				1.00	2.69 cc	2.65 cc	1.01	io =24.1	-6%	
42	I	21.2	04/13/1999	9	32	0		1.00	96.35	7.40	p	159.53	5.32E-08	
	F	22.7	04/13/1999	18	8	0		1.00	90.00	13.95	p	146.63	5.36E-08	
		Rt= 0.957	dT =	516.00 min				1.00	1.48 cc	1.53 cc	0.97	io =24.1	-10%	
43	I	22.7	04/13/1999	18	15	0		1.00	96.30	7.10	p	159.78	5.61E-08	
	F	21.3	04/14/1999	9	8	0		1.00	84.80	18.40	p	136.98	5.65E-08	

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.627 cm ε_{axial} =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation.	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-4										
Stage No.	4	sc	105.0	psi	System: p=pipette a = annulus b =both						
Apparatus No.	5	Ub	100.0	psi	Head Tube Area =	0.2335	0.0000	0.0000	cm2	cm2	
(s'c)max= 5.0 psi	(s'c)min= 2.7 psi	'c)av= 3.8 psi			Tail Tube Area =	0.2335	0.0000	0.0000	cm2	cm2	

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
		Rt= 0.956	dT =	893.00 min				1.00	2.69 cc	2.64 cc	1.02	io =24.1	-5%
44	I	21.3	04/14/1999	9	17	0		1.00	96.50	7.90	p	159.18	5.46E-08
	F	22.7	04/14/1999	18	3	0		1.00	89.85	14.70	p	145.73	5.50E-08
		Rt= 0.956	dT =	526.00 min				1.00	1.55 cc	1.59 cc	0.98	io =24.0	-8%
45	I	22.7	04/14/1999	18	9			1.00	96.10	7.50	p	159.18	5.38E-08
	F	23.4	04/15/1999	17	52			1.00	79.40	24.15	p	125.83	5.26E-08
		Rt= 0.930	dT =	1423.00 min				1.00	3.90 cc	3.89 cc	1.00	io =24.0	-12%
46	I	23.4	04/15/1999	17	58			1.00	96.45	7.80	p	159.23	5.57E-08
	F	22.2	04/16/1999	17	1			1.00	79.55	24.45	p	125.68	5.49E-08
		Rt= 0.936	dT =	1383.00 min				1.00	3.95 cc	3.89 cc	1.02	io =24.0	-8%
47	I	22.2	04/16/1999	17	7			1.00	96.35	7.90	p	159.03	5.15E-08
	F	20.8	04/19/1999	9	6			1.00	60.00	43.90	p	86.68	5.24E-08
		Rt= 0.968	dT =	3839.00 min				1.00	8.49 cc	8.41 cc	1.01	io =24.0	-12%
48	I	20.8	04/19/1999	9	13			1.00	96.65	7.90	p	159.33	4.80E-08
	F	21.5	04/20/1999	16	59			1.00	77.20	27.45	p	120.33	4.93E-08
		Rt= 0.976	dT =	1906.00 min				1.00	4.54 cc	4.56 cc	0.99	io =24.0	-17%
49	I	21.5	04/20/1999	17	6			1.00	96.60	7.30	p	159.88	3.52E-08
	F	23.5	04/21/1999	17	11			1.00	85.30	19.10	p	136.78	3.49E-08
		Rt= 0.943	dT =	1445.00 min				1.00	2.64 cc	2.76 cc	0.96	io =24.1	-41%
50	I	23.5	04/21/1999	17	16			1.00	96.20	7.45	p	159.33	1.93E-08
	F	22.1	04/22/1999	13	43			1.00	90.80	13.20	p	148.18	1.90E-08
		Rt= 0.936	dT =	1227.00 min				1.00	1.26 cc	1.34 cc	0.94	io =24.0	-68%
51	I	22.1	04/22/1999	16	1			2.00	94.85	8.70	p	227.32	5.96E-08
	F	21.8	04/23/1999	9	20			2.00	75.00	28.20	p	187.97	6.00E-08
		Rt= 0.957	dT =	1039.00 min				2.00	4.63 cc	4.55 cc	1.02	io =34.3	1%
52	I	21.8	04/23/1999	9	30			2.00	96.30	8.00	p	229.47	6.00E-08
	F	21.4	04/23/1999	15	51			2.00	88.60	15.85	p	213.92	6.09E-08
		Rt= 0.965	dT =	381.00 min				2.00	1.80 cc	1.83 cc	0.98	io =34.6	2%
53	I	21.4	04/23/1999	15	55			2.00	96.65	7.25	p	230.57	5.87E-08
	F	21.4	04/26/1999	9	4			2.00	38.35	65.60	p	113.92	6.00E-08
		Rt= 0.970	dT =	3909.00 min				2.00	13.61 cc	13.62 cc	1.00	io =34.8	1%
54	I	21.4	04/26/1999	9	10			2.00	96.30	7.45	p	230.02	5.96E-08
	F	21.3	04/26/1999	17	19			2.00	86.60	17.45	p	210.32	6.10E-08
		Rt= 0.971	dT =	489.00 min				2.00	2.26 cc	2.34 cc	0.97	io =34.7	2%
55	I	21.3	04/26/1999	17	22			2.00	96.30	6.95	p	230.52	5.77E-08
	F	21.5	04/27/1999	9	5			2.00	78.55	24.70	p	195.02	5.90E-08
		Rt= 0.970	dT =	943.00 min				2.00	4.14 cc	4.14 cc	1.00	io =34.8	-1%
56	I	21.5	04/27/1999	9	12			2.00	96.30	8.05	p	229.42	5.88E-08
	F	21.0	04/27/1999	17	9			2.00	86.80	17.50	p	210.47	6.03E-08
		Rt= 0.974	dT =	477.00 min				2.00	2.22 cc	2.21 cc	1.01	io =34.6	1%
57	I	21.0	04/27/1999	17	15			2.00	96.15	7.50	p	229.82	5.80E-08
	F	21.4	04/28/1999	9	7			2.00	78.20	25.40	p	193.97	5.95E-08
		Rt= 0.975	dT =	952.00 min				2.00	4.19 cc	4.18 cc	1.00	io =34.7	0%
58	I	21.4	04/28/1999	9	13			2.00	96.30	7.70	p	229.77	5.90E-08

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.627 cm ε_{axial} =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in:	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant:	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used: Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-4									
Stage No.	4	sc	105.0	psi	System: p=pipette a = annulus b =both					
Apparatus No.	5	Ub	100.0	psi	Head Tube Area =	0.2335	0.0000	0.0000	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.7 psi		'c)av= 3.8 psi		Tail Tube Area =	0.2335	0.0000	0.0000	cm2	cm2

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial	Stage	Temp.	Time			Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
	F	21.2	04/28/1999	18	1		2.00	85.80	18.15	p	208.82	6.04E-08
		Rt= 0.973	dT =	528.00 min			2.00	2.45 cc	2.44 cc	1.00	io =34.7	1%
59	I	21.2	04/28/1999	18	8		2.00	96.25	7.60	p	229.82	5.73E-08
	F	21.6	04/29/1999	9	7		2.00	79.40	24.40	p	196.17	5.86E-08
		Rt= 0.970	dT =	899.00 min			2.00	3.93 cc	3.92 cc	1.00	io =34.7	-2%
60	I	21.6	04/29/1999	9	14		2.00	96.00	7.10	p	230.07	5.78E-08
	F	21.2	04/29/1999	16	24		2.00	87.55	15.55	p	213.17	5.90E-08
		Rt= 0.970	dT =	430.00 min			2.00	1.97 cc	1.97 cc	1.00	io =34.7	-1%
61	I	21.2	04/29/1999	16	29		2.00	96.00	7.25	p	229.92	5.73E-08
	F	21.5	04/30/1999	9	13		2.00	77.35	25.85	p	192.67	5.86E-08
		Rt= 0.971	dT =	1004.00 min			2.00	4.35 cc	4.34 cc	1.00	io =34.7	-2%
62	I	21.5	04/30/1999	9	21		2.00	96.05	7.50	p	229.72	5.81E-08
	F	21.0	04/30/1999	18	9		2.00	85.70	17.80	p	209.07	5.95E-08
		Rt= 0.974	dT =	528.00 min			2.00	2.42 cc	2.41 cc	1.00	io =34.7	0%
63	I	21.0	04/30/1999	18	13		2.00	96.10	7.75	p	229.52	5.76E-08
	F	21.4	05/02/1999	16	21		2.00	51.35	51.90	p	140.62	5.91E-08
		Rt= 0.975	dT =	2768.00 min			2.00	10.45 cc	10.31 cc	1.01	io =34.6	-1%
64	I	21.4	05/02/1999	16	26		2.00	95.75	8.60	p	228.32	5.83E-08
	F	21.5	05/04/1999	9	35		2.00	54.90	49.30	p	146.77	5.94E-08
		Rt= 0.969	dT =	2469.00 min			2.00	9.54 cc	9.50 cc	1.00	io =34.5	0%
65	I	21.5	05/04/1999	9	39		2.00	96.20	8.40	p	228.97	5.85E-08
	F	21.4	05/04/1999	18	2		2.00	86.40	18.40	p	209.17	5.97E-08
		Rt= 0.969	dT =	503.00 min			2.00	2.29 cc	2.34 cc	0.98	io =34.6	0%
66	I	21.4	05/04/1999	18	9		2.00	96.25	6.90	p	230.52	5.72E-08
	F	21.5	05/05/1999	9	13		2.00	79.30	23.80	p	196.67	5.83E-08
		Rt= 0.969	dT =	904.00 min			2.00	3.96 cc	3.95 cc	1.00	io =34.8	-2%
67	I	21.5	05/05/1999	9	21		2.00	96.15	7.80	p	229.52	5.74E-08
	F	21.5	05/05/1999	18	36		2.00	85.45	18.50	p	208.12	5.85E-08
		Rt= 0.968	dT =	555.00 min			2.00	2.50 cc	2.50 cc	1.00	io =34.6	-2%
68	I	21.5	05/05/1999	18	42		2.00	96.10	7.35	p	229.92	5.68E-08
	F	21.5	05/06/1999	9	11		2.00	79.90	23.50	p	197.57	5.79E-08
		Rt= 0.968	dT =	869.00 min			2.00	3.78 cc	3.77 cc	1.00	io =34.7	-3%
69	I	21.5	05/06/1999	9	22		2.00	96.15	8.10	p	229.22	5.64E-08
	F	21.2	05/06/1999	17	57		2.00	86.35	17.85	p	209.67	5.76E-08
		Rt= 0.971	dT =	515.00 min			2.00	2.29 cc	2.28 cc	1.01	io =34.6	-3%
70	I	21.2	05/06/1999	18	1		2.00	96.25	7.30	p	230.12	5.59E-08
	F	21.5	05/07/1999	9	25		2.00	79.40	24.20	p	196.37	5.71E-08
		Rt= 0.971	dT =	924.00 min			2.00	3.93 cc	3.95 cc	1.00	io =34.7	-4%
71	I	21.5	05/07/1999	9	30		2.00	96.25	7.20	p	230.22	5.61E-08
	F	21.3	05/07/1999	17	47		2.00	86.80	16.65	p	211.32	5.73E-08
		Rt= 0.970	dT =	497.00 min			2.00	2.21 cc	2.21 cc	1.00	io =34.7	-4%
72	I	21.3	05/07/1999	17	51		2.00	96.25	7.00	p	230.42	5.50E-08
	F	21.4	05/08/1999	21	15		2.00	68.30	34.90	p	174.57	5.62E-08
		Rt= 0.971	dT =	1644.00 min			2.00	6.53 cc	6.51 cc	1.00	io =34.8	-6%

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.627 cm ε_{axial} =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or				
	x	with stones or		Stones with filter paper or		top + bottom		
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination				
5) Direction of permeant :	x	Up during or		Down during permeation				
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes		
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only		
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)

Cell No.	H-4									
Stage No.	4	sc	105.0	psi	System: p=pipette a = annulus b =both					
Apparatus No.	5	Ub	100.0	psi	Head Tube Area =	0.2335	0.0000	0.0000	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.7 psi	'c)av= 3.8 psi			Tail Tube Area =	0.2335	0.0000	0.0000	cm2	cm2

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial	Stage	Temp	Time			Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary	Permeability (cm/sec) Final at 20°C
73	I	21.4	05/08/1999	21	19		2.00	96.10	7.50	p	229.77	5.27E-08	
	F	21.2	05/10/1999	9	16		2.00	61.85	40.95	p	162.07	5.39E-08	
		Rt= 0.973	dT =	2157.00 min			2.00	8.00 cc	7.81 cc	1.02	io =34.7	-9%	
74	I	21.2	05/10/1999	9	20		2.00	96.10	7.50	p	229.77	5.25E-08	
	F	21.0	05/10/1999	16	58		2.00	87.90	15.65	p	213.42	5.40E-08	
		Rt= 0.978	dT =	458.00 min			2.00	1.91 cc	1.90 cc	1.01	io =34.7	-9%	
75	I	21.0	05/10/1999	17	4		2.00	96.10	7.45	p	229.82	5.76E-08	
	F	21.3	05/11/1999	9	14		2.00	77.70	25.30	p	193.57	5.92E-08	
		Rt= 0.976	dT =	970.00 min			2.00	4.30 cc	4.17 cc	1.03	io =34.7	-1%	
76	I	21.3	05/11/1999	9	23		2.00	96.60	7.50	p	230.27	5.78E-08	
	F	21.0	05/11/1999	19	19		2.00	84.85	18.85	p	207.17	5.93E-08	
		Rt= 0.976	dT =	596.00 min			2.00	2.74 cc	2.65 cc	1.04	io =34.7	0%	
77	I	21.0	05/11/1999	17	26		2.00	96.20	7.50	p	229.87	4.66E-08	
	F	21.5	05/12/1999	9	11		2.00	81.55	21.95	p	200.77	4.78E-08	
		Rt= 0.974	dT =	945.00 min			2.00	3.42 cc	3.37 cc	1.01	io =34.7	-20%	
78	I	21.5	05/12/1999	9	21		2.00	96.20	7.65	p	229.72	5.51E-08	
	F	21.2	05/12/1999	17	15		2.00	87.25	16.40	p	212.02	5.63E-08	
		Rt= 0.971	dT =	474.00 min			2.00	2.09 cc	2.04 cc	1.02	io =34.7	-5%	
79	I	21.2	05/12/1999	17	20		2.00	96.20	7.25	p	230.12	5.31E-08	
	F	21.2	05/13/1999	9	15		2.00	79.80	24.05	p	196.92	5.45E-08	
		Rt= 0.975	dT =	955.00 min			2.00	3.83 cc	3.92 cc	0.98	io =34.7	-8%	
80	I	21.2	05/13/1999	9	24		2.00	96.10	7.50	p	229.77	5.63E-08	
	F	21.2	05/13/1999	16	43		2.00	87.70	15.90	p	212.97	5.78E-08	
		Rt= 0.975	dT =	439.00 min			2.00	1.96 cc	1.96 cc	1.00	io =34.7	-3%	
81	I	21.2	05/13/1999	17	34		2.00	96.05	7.40	p	229.82	5.77E-08	
	F	21.3	05/14/1999	9	4		2.00	78.60	24.85	p	194.92	5.91E-08	
		Rt= 0.974	dT =	930.00 min			2.00	4.07 cc	4.07 cc	1.00	io =34.7	-1%	
82	I	21.3	05/14/1999	9	8		2.00	96.10	7.75	p	229.52	5.83E-08	
	F	21.2	05/14/1999	19	57		2.00	83.35	20.20	p	204.32	5.98E-08	
		Rt= 0.974	dT =	649.00 min			2.00	2.98 cc	2.91 cc	1.02	io =34.6	0%	
83	I	21.2	05/14/1999	20	0		2.00	96.20	7.60	p	229.77	5.63E-08	
	F	21.4	05/15/1999	11	15		2.00	79.20	24.25	p	196.12	5.77E-08	
		Rt= 0.973	dT =	915.00 min			2.00	3.97 cc	3.89 cc	1.02	io =34.7	-3%	
84	I	21.4	05/15/1999	11	17		2.00	95.00	7.55	p	228.62	5.43E-08	
	F	21.3	05/16/1999	12	23		2.00	69.20	32.55	p	177.82	5.55E-08	
		Rt= 0.971	dT =	1506.00 min			2.00	6.02 cc	5.84 cc	1.03	io =34.5	-7%	
85	I	21.3	05/16/1999	12	27		2.00	94.10	8.20	p	227.07	5.39E-08	
	F	21.5	05/17/1999	9	32		2.00	72.40	29.40	p	184.17	5.50E-08	
		Rt= 0.970	dT =	1265.00 min			2.00	5.07 cc	4.95 cc	1.02	io =34.3	-8%	
86	I	21.5	05/17/1999	9	40		2.00	96.25	7.35	p	230.07	5.92E-08	
	F	21.5	05/17/1999	17	54		2.00	86.20	17.05	p	210.32	6.03E-08	
		Rt= 0.968	dT =	494.00 min			2.00	2.35 cc	2.26 cc	1.04	io =34.7	1%	
87	I	21.5	05/17/1999	18	2		2.00	96.20	7.15	p	230.22	5.87E-08	
	F	21.5	05/18/1999	9	16		2.00	78.40	24.30	p	195.27	5.97E-08	

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.627 cm ε_{axial} =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or				
	x	with stones or		Stones with filter paper or		top + bottom		
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination				
5) Direction of permeant :	x	Up during or		Down during permeation				
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes		
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only		
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)

Cell No.	H-4				
Stage No.:	4	sc	105.0	psi	System: p=pipette a = annulus b =both
Apparatus No.	5	Ub	100.0	psi	Head Tube Area = 0.2335 0.0000 0.0000 cm2 cm2
(s'c)max= 5.0 psi	(s'c)min= 2.7 psi	'c)av= 3.8 psi			Tail Tube Area = 0.2335 0.0000 0.0000 cm2 cm2

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial	Stage	Temp.	Time			Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary	Permeability (cm/sec) Final at 20°C
		Rt= 0.968	dT =	914.00 min			2.00	4.16 cc	4.00 cc	1.04	io =34.7	0%	
88	I	21.5	05/18/1999	9	30		2.00	95.95	8.20	p	228.92	5.64E-08	
	F	21.4	05/18/1999	17	57		2.00	86.15	17.65	p	209.67	5.75E-08	
		Rt= 0.969	dT =	507.00 min			2.00	2.29 cc	2.21 cc	1.04	io =34.5	-3%	
89	I	21.4	05/18/1999	18	4		2.00	96.25	7.30	p	230.12	5.56E-08	
	F	21.6	05/19/1999	9	45		2.00	79.00	24.20	p	195.97	5.66E-08	
		Rt= 0.968	dT =	941.00 min			2.00	4.03 cc	3.95 cc	1.02	io =34.7	-5%	
90	I	21.6	05/19/1999	9	49		2.00	95.95	7.20	p	229.92	5.59E-08	
	F	21.4	05/19/1999	17	12		2.00	87.50	15.60	p	213.07	5.70E-08	
		Rt= 0.968	dT =	443.00 min			2.00	1.97 cc	1.96 cc	1.01	io =34.7	-4%	
91	I	21.4	05/19/1999	17	14		2.00	96.20	7.00	p	230.37	5.14E-08	
	F	21.4	05/20/1999	9	16		2.00	79.85	23.10	p	197.92	5.25E-08	
		Rt= 0.970	dT =	962.00 min			2.00	3.82 cc	3.76 cc	1.02	io =34.8	-12%	
92	I	21.4	05/20/1999	9	24		2.00	96.25	7.30	p	230.12	5.47E-08	
	F	21.3	05/20/1999	17	46		2.00	86.95	16.60	p	211.52	5.59E-08	
		Rt= 0.971	dT =	502.00 min			2.00	2.17 cc	2.17 cc	1.00	io =34.7	-6%	
93	I	21.3	05/20/1999	17	56		2.00	96.10	7.00	p	230.27	5.67E-08	
	F	21.5	05/21/1999	9	16		2.00	79.00	24.00	p	196.17	5.79E-08	
		Rt= 0.970	dT =	920.00 min			2.00	3.99 cc	3.97 cc	1.01	io =34.7	-3%	
94	I	21.5	05/21/1999	9	21		2.00	96.35	7.15	p	230.37	5.53E-08	
	F	21.2	05/21/1999	18	37		2.00	85.65	17.20	p	209.62	5.65E-08	
		Rt= 0.971	dT =	556.00 min			2.00	2.50 cc	2.35 cc	1.06	io =34.8	-5%	
95	I	21.2	05/21/1999	18	41		2.00	96.40	7.00	p	230.57	5.38E-08	
	F	21.5	05/24/1999	10	28		2.00	41.90	60.50	p	122.57	5.50E-08	
		Rt= 0.971	dT =	3827.00 min			2.00	12.73 cc	12.49 cc	1.02	io =34.8	-8%	
96	I	21.5	05/24/1999	10	35		2.00	96.20	7.00	p	230.37	5.39E-08	
	F	21.4	05/25/1999	9	26		2.00	73.00	30.60	p	183.57	5.50E-08	
		Rt= 0.969	dT =	1371.00 min			2.00	5.42 cc	5.51 cc	0.98	io =34.8	-8%	
97	I	21.4	05/25/1999	9	37		2.00	96.25	7.55	p	229.87	5.76E-08	
	F	21.2	05/25/1999	18	13		2.00	86.25	17.60	p	209.82	5.90E-08	
		Rt= 0.973	dT =	516.00 min			2.00	2.34 cc	2.35 cc	1.00	io =34.7	-1%	
98	I	21.2	05/25/1999	18	14		2.00	96.35	7.35	p	230.17	5.61E-08	
	F	21.0	05/26/1999	17	48		2.00	71.40	32.20	p	180.37	5.78E-08	
		Rt= 0.978	dT =	1414.00 min			2.00	5.83 cc	5.80 cc	1.00	io =34.7	-3%	
99	I	21.0	05/26/1999	17	55		2.00	96.15	7.05	p	230.27	5.47E-08	
	F	21.2	05/27/1999	18	28		2.00	70.95	32.30	p	179.82	5.62E-08	
		Rt= 0.978	dT =	1473.00 min			2.00	5.88 cc	5.90 cc	1.00	io =34.7	-6%	
100	I	21.2	05/27/1999	18	32		2.00	96.10	7.45	p	229.82	5.99E-08	
	F	21.7	05/28/1999	17	14		2.00	70.60	32.90	p	178.87	6.11E-08	
		Rt= 0.969	dT =	1362.00 min			2.00	5.95 cc	5.94 cc	1.00	io =34.7	3%	
101	I	21.7	05/28/1999	17	37		2.00	96.10	7.00	p	230.27	4.15E-08	
	F	21.5	06/01/1999	9	15		2.00	39.60	62.95	p	117.82	4.22E-08	
		Rt= 0.965	dT =	5258.00 min			2.00	13.19 cc	13.06 cc	1.01	io =34.7	-29%	
102	I	21.5	06/01/1999	9	32		2.00	95.90	7.90	p	229.17	6.31E-08	

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.627 cm ε_{axial} =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used: Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-4				
Stage No.	4	sc	105.0	psi	System: p=pipette a = annulus b =both
Apparatus No.	5	Ub	100.0	psi	

Head Tube Area = 0.2335 0.0000 0.0000 cm2 cm2

Tail Tube Area = 0.2335 0.0000 0.0000 cm2 cm2

(s'c)max= 5.0 psi (s'c)min= 2.7 psi 'c)av= 3.8 psi

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial	Stage	Temp.	Time			Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary	Permeability (cm/sec) Final at 20°C
	F	21.5	06/02/1999	16	36		2.00	61.10	42.60	p	159.67	6.43E-08	
		Rt= 0.968	dT =	1864.00	min		2.00	8.13 cc	8.10 cc	1.00	io =34.6	8%	
103	I	21.5	06/02/1999	16	55		2.00	95.85	7.60	p	229.42	6.22E-08	
	F	21.5	06/03/1999	18	8		2.00	67.00	36.30	p	171.87	6.33E-08	
		Rt= 0.968	dT =	1513.00	min		2.00	6.74 cc	6.70 cc	1.01	io =34.6	6%	
104	I	21.5	06/03/1999	18	18		2.00	96.10	7.30	p	229.97	5.87E-08	
	F	21.1	06/04/1999	17	51		2.00	70.15	33.05	p	178.27	6.01E-08	
		Rt= 0.973	dT =	1413.00	min		2.00	6.06 cc	6.01 cc	1.01	io =34.7	1%	
105	I	21.1	06/04/1999	18	5		2.00	96.40	7.10	p	230.47	5.91E-08	
	F	21.7	06/07/1999	10	18		2.00	38.25	64.95	p	114.47	6.04E-08	
		Rt= 0.970	dT =	3853.00	min		2.00	13.58 cc	13.51 cc	1.01	io =34.8	1%	
106	I	21.7	06/07/1999	10	32		2.00	96.00	7.40	p	229.77	6.29E-08	
	F	23.0	06/08/1999	18	55		2.00	60.05	43.35	p	157.87	6.27E-08	
		Rt= 0.947	dT =	1943.00	min		2.00	8.39 cc	8.39 cc	1.00	io =34.7	5%	
107	I	23.0	06/08/1999	19	7		2.00	96.05	7.55	p	229.67	5.93E-08	
	F	22.0	06/09/1999	18	38		2.00	69.85	33.40	p	177.62	5.89E-08	
		Rt= 0.943	dT =	1411.00	min		2.00	6.12 cc	6.04 cc	1.01	io =34.7	-1%	
108	I	22.0	06/09/1999	18	47		2.00	95.95	7.60	p	229.52	5.69E-08	
	F	21.3	06/10/1999	18	43		2.00	70.40	33.00	p	178.57	5.77E-08	
		Rt= 0.964	dT =	1436.00	min		2.00	5.97 cc	5.93 cc	1.01	io =34.6	-3%	
109	I	21.3	06/10/1999	18	54		2.00	96.10	7.25	p	230.02	5.75E-08	
	F	21.3	06/11/1999	18	21		2.00	70.75	32.50	p	179.42	5.89E-08	
		Rt= 0.973	dT =	1407.00	min		2.00	5.92 cc	5.90 cc	1.00	io =34.7	-1%	
110	I	21.3	06/11/1999	18	25		2.00	96.40	7.60	p	229.97	5.63E-08	
	F	21.4	06/12/1999	12	4		2.00	77.15	26.80	p	191.52	5.75E-08	
		Rt= 0.971	dT =	1059.00	min		2.00	4.49 cc	4.48 cc	1.00	io =34.7	-3%	
111	I	21.4	06/12/1999	12	8		2.00	96.60	7.15	p	230.62	3.62E-08	
	F	21.3	06/14/1999	9	26		2.00	66.45	37.10	p	170.52	3.70E-08	
		Rt= 0.971	dT =	2718.00	min		2.00	7.04 cc	6.99 cc	1.01	io =34.8	-38%	
113	I	21.3	06/15/1999	19	23		2.00	95.65	6.65	p	230.17	5.52E-08	
	F	21.3	06/16/1999	17	7		2.00	72.40	29.05	p	184.52	5.65E-08	
		Rt= 0.973	dT =	1304.00	min		2.00	5.43 cc	5.23 cc	1.04	io =34.7	-5%	
114	I	21.3	06/16/1999	17	21		2.00	95.95	7.20	p	229.92	5.95E-08	
	F	21.2	06/17/1999	18	50		2.00	67.80	35.10	p	173.87	6.10E-08	
		Rt= 0.974	dT =	1529.00	min		2.00	6.57 cc	6.51 cc	1.01	io =34.7	2%	
115	I	21.2	06/17/1999	19	5		2.00	96.00	7.60	p	229.57	5.59E-08	
	F	21.2	06/18/1999	16	1		2.00	73.70	29.80	p	185.07	5.73E-08	
		Rt= 0.975	dT =	1256.00	min		2.00	5.21 cc	5.18 cc	1.00	io =34.6	-4%	
116	I	21.2	06/18/1999	16	8		2.00	96.30	7.00	p	230.47	5.51E-08	
	F	21.7	06/20/1999	12	18		2.00	54.50	48.45	p	147.22	5.62E-08	
		Rt= 0.969	dT =	2650.00	min		2.00	9.76 cc	9.68 cc	1.01	io =34.8	-6%	
117	I	21.7	06/20/1999	12	20		2.00	95.35	7.65	p	228.87	5.54E-08	
	F	21.2	06/21/1999	18	8		2.00	65.30	37.60	p	168.87	5.65E-08	
		Rt= 0.969	dT =	1788.00	min		2.00	7.02 cc	6.99 cc	1.00	io =34.5	-5%	

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.627 cm ε_{axial} =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No. H-4

Stage No. 4 sc 105.0 psi System: p=pipette a = annulus b =both

Apparatus No. 5 Ub 100.0 psi

(s'c)max= 5.0 psi (s'c)min= 2.7 psi 'c)av= 3.8 psi

Head Tube Area =	0.2335	0.0000	0.0000	cm2 cm2
Tail Tube Area =	0.2335	0.0000	0.0000	cm2 cm2

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial	Stage	Temp.	Time			Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary	Permeability (cm/sec) Final at 20°C
118	I	21.2	06/21/1999	18	13		2.00	96.25	7.25	p	230.17	5.43E-08	
	F	21.9	06/22/1999	18	3		2.00	71.90	31.70	p	181.37	5.52E-08	
		Rt= 0.967	dT =	1430.00	min		2.00	5.69 cc	5.71 cc	1.00	io =34.7	-7%	
119	I	21.9	06/22/1999	18	11		2.00	95.95	7.65	p	229.47	5.55E-08	
	F	22.2	06/23/1999	18	45		2.00	70.45	33.15	p	178.47	5.58E-08	
		Rt= 0.954	dT =	1474.00	min		2.00	5.95 cc	5.95 cc	1.00	io =34.6	-6%	
120	I	22.2	06/23/1999	18	61		2.00	96.30	7.45	p	230.02	5.33E-08	
	F	22.2	06/24/1999	17	37		2.00	73.40	30.35	p	184.22	5.33E-08	
		Rt= 0.951	dT =	1356.00	min		2.00	5.35 cc	5.35 cc	1.00	io =34.7	-10%	
121	I	22.2	06/24/1999	17	52		2.00	96.15	7.65	p	229.67	5.13E-08	
	F	22.2	06/25/1999	16	59		2.00	73.55	30.10	p	184.62	5.13E-08	
		Rt= 0.951	dT =	1387.00	min		2.00	5.28 cc	5.24 cc	1.01	io =34.7	-14%	
122	I	22.2	06/25/1999	17	17		2.00	95.90	7.35	p	229.72	5.05E-08	
	F	21.6	06/26/1999	11	52		2.00	77.50	25.45	p	193.22	5.09E-08	
		Rt= 0.958	dT =	1115.00	min		2.00	4.30 cc	4.23 cc	1.02	io =34.7	-14%	
123	I	21.6	06/26/1999	11	58		2.00	95.90	7.40	p	229.67	4.87E-08	
	F	21.4	06/28/1999	8	27		2.00	57.95	45.00	p	154.12	4.96E-08	
		Rt= 0.968	dT =	2669.00	min		2.00	8.86 cc	8.78 cc	1.01	io =34.7	-17%	
124	I	21.4	06/28/1999	8	50		2.00	95.95	7.35	p	229.77	4.88E-08	
	F	21.6	06/29/1999	17	58		2.00	66.30	36.90	p	170.57	4.97E-08	
		Rt= 0.968	dT =	1988.00	min		2.00	6.92 cc	6.90 cc	1.00	io =34.7	-16%	
125	I	21.6	06/29/1999	18	7		2.00	96.20	7.35	p	230.02	4.84E-08	
	F	21.5	06/30/1999	16	25		2.00	75.30	27.90	p	188.57	4.92E-08	
		Rt= 0.967	dT =	1338.00	min		2.00	4.88 cc	4.80 cc	1.02	io =34.7	-17%	
126	I	21.5	06/30/1999	16	30		2.00	96.15	7.20	p	230.12	4.68E-08	
	F	21.5	07/01/1999	18	4		2.00	73.35	29.90	p	184.62	4.76E-08	
		Rt= 0.968	dT =	1534.00	min		2.00	5.32 cc	5.30 cc	1.00	io =34.7	-20%	
127	I	21.5	07/01/1999	18	12		2.00	96.00	7.40	p	229.77	5.42E-08	
	F	21.9	07/02/1999	17	48		2.00	71.85	31.50	p	181.52	5.49E-08	
		Rt= 0.963	dT =	1416.00	min		2.00	5.64 cc	5.63 cc	1.00	io =34.7	-8%	
128	I	21.9	07/02/1999	17	58		2.00	96.60	7.10	p	230.67	5.30E-08	
	F	21.5	07/03/1999	11	38		2.00	78.25	25.30	p	194.12	5.37E-08	
		Rt= 0.963	dT =	1060.00	min		2.00	4.28 cc	4.25 cc	1.01	io =34.8	-10%	
129	I	21.5	07/03/1999	11	46		2.00	96.50	6.90	p	230.77	5.13E-08	
	F	21.9	07/05/1999	11	31		2.00	54.40	48.65	p	146.92	5.20E-08	
		Rt= 0.963	dT =	2865.00	min		2.00	9.83 cc	9.75 cc	1.01	io =34.8	-13%	
130	I	21.9	07/05/1999	11	50		2.00	93.65	7.50	p	227.32	5.87E-08	
	F	30.0	07/06/1999	17	12		2.00	63.55	39.30	p	165.42	5.31E-08	
		Rt= 0.859	dT =	1762.00	min		2.00	7.03 cc	7.43 cc	0.95	io =34.3	-11%	
131	I	30.0	07/06/1999	17	23		2.00	96.00	7.60	p	229.57	6.31E-08	
	F	23.6	07/07/1999	15	20		2.00	69.80	33.10	p	177.87	5.56E-08	
		Rt= 0.838	dT =	1317.00	min		2.00	6.12 cc	5.95 cc	1.03	io =34.6	-7%	
132	I	23.6	07/07/1999	17	24		2.00	96.25	7.05	p	230.37	5.71E-08	
	F	21.8	07/08/1999	18	19		2.00	69.30	33.25	p	177.22	5.64E-08	

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.627 cm ε_{axial} =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or				
	x	with stones or		Stones with filter paper or		top + bottom		
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination				
5) Direction of permeant	x	Up during or		Down during permeation				
3) During saturation: Water flushed up sides of specimen to remove air					x	No		Yes
4) During consolidation:	x	Top and bottom drainage or				Top		Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)

Cell No	H-4				
Stage No	4	sc	105.0	psi	System: p=pipette a = annulus b =both
Apparatus No	5	Ub	100.0	psi	

(s'c)max= 5.0 psi (s'c)min= 2.7 psi 'c)av= 3.8 psi

Head Tube Area =	0.2335	0.0000	0.0000	cm2	cm2
Tail Tube Area =	0.2335	0.0000	0.0000	cm2	cm2

Preliminary Length/A

Lo =	2.695
dLc=	0.086
Lc=	2.609
Lo=	6.845
Ao =	42.40
Vo =	290.23
Lc=	6.627
dVc = 3 Vo * (dLc/L	
dVc=	27.78
Vc =	262.448
Ac=	39.604

Trial	Stage	Temp	Time			Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
		Rt= 0.938	dT =	1495.00 min			2.00	6.29 cc	6.12 cc	1.03	io =34.8	-5%
133	I	21.8	07/08/1999	18	22		2.00	96.10	7.85	p	229.42	5.08E-08
	F	21.5	07/09/1999	17	58		2.00	73.30	30.55	p	183.92	5.16E-08
		Rt= 0.964	dT =	1416.00 min			2.00	5.32 cc	5.30 cc	1.00	io =34.6	-13%
134	I	21.5	07/09/1999	18	12		2.00	96.40	6.55	p	231.02	5.50E-08
	F	20.6	07/10/1999	12	2		2.00	77.20	25.55	p	192.82	5.67E-08
		Rt= 0.979	dT =	1070.00 min			2.00	4.48 cc	4.44 cc	1.01	io =34.9	-5%
135	I	20.6	07/10/1999	12	13		2.00	95.10	7.60	p	228.67	5.07E-08
	F	20.8	07/12/1999	18	6		2.00	49.95	52.95	p	138.17	5.27E-08
		Rt= 0.987	dT =	3233.00 min			2.00	10.54 cc	10.59 cc	1.00	io =34.5	-11%

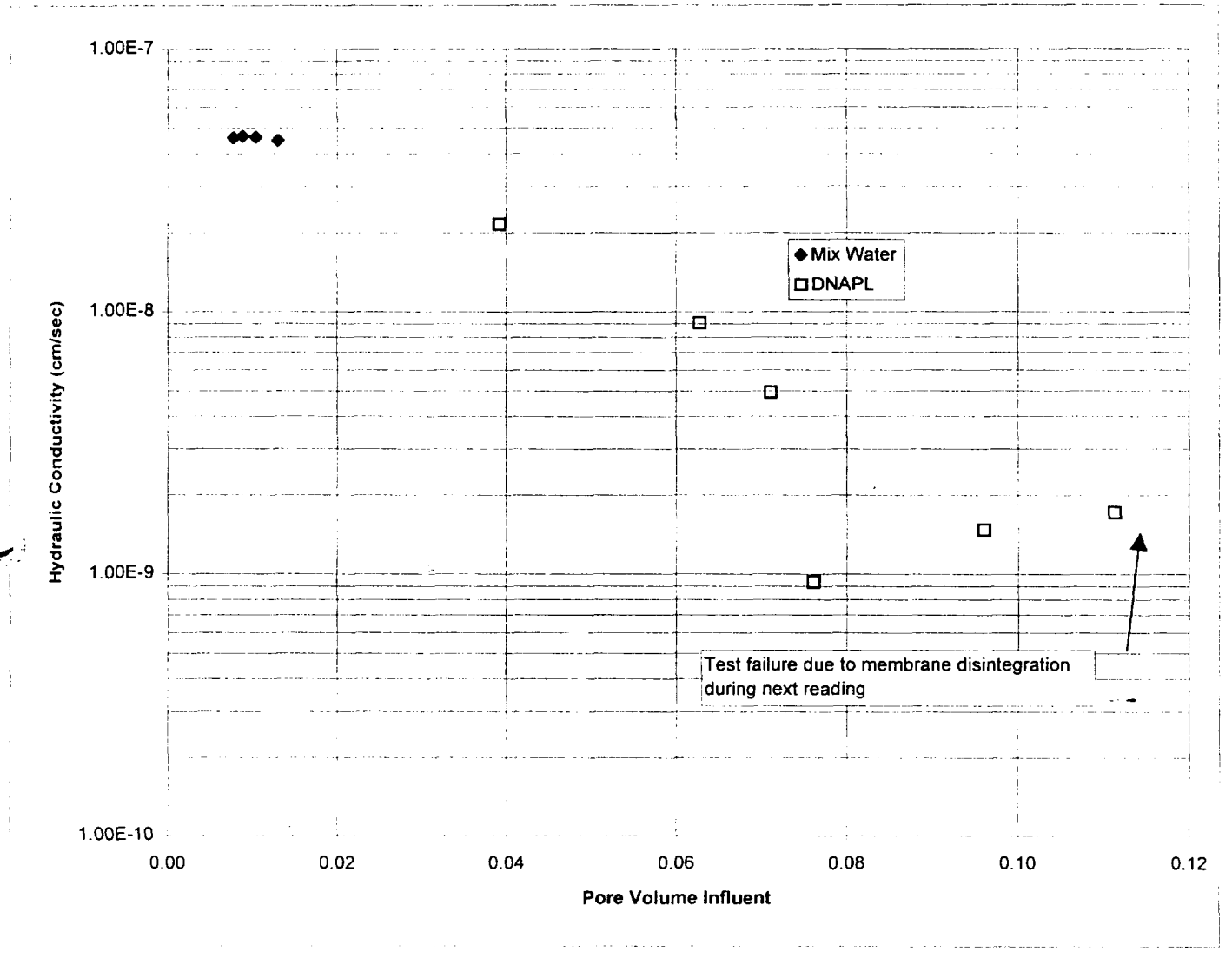
TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.627 cm ε_{axial} =

Project No. 3808E06011
Project Name: DETREX
Boring No. Composite
Sample No. Barakade 90
3% dry

Test No.: Compsum1.



PERMEABILITY TEST SUMMARY
ASTM D5084

Project No. 3808E06011
Project Name: DETREX

Boring No. Composite
Sample No. Barakade 90 3% dry

Test No.: p5675.xls
Volume Voids 107.0 cm3

					Influent			Effluent		Sum	
Stage	Permeant Type	Confining Stress (psi)	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
1	Site Mix	5	25.6	5/17/99	0.2	0.2	0.00	0.2	0.2	0.0	5.03E-8
2	Site Mix	5	26.1	5/17/99	0.1	0.4	0.00	0.1	0.3	0.0	5.27E-8
3	Site Mix	5	27.6	5/17/99	0.2	0.5	0.00	0.2	0.5	0.0	5.25E-8
4	Site Mix	5	27.3	5/17/99	0.2	0.7	0.01	0.2	0.7	0.0	4.89E-8
1	Site Mix	10	27.3	5/19/99	0.1	0.8	0.01	0.1	0.8	0.0	4.59E-8
2	Site Mix	10	26.3	5/19/99	0.1	0.9	0.01	0.1	0.9	0.0	4.66E-8
3	Site Mix	10	27.8	5/19/99	0.2	1.1	0.01	0.2	1.1	0.0	4.63E-8
4	Site Mix	10	28.0	5/19/99	0.3	1.4	0.01	0.3	1.4	0.0	4.50E-8
1	DNAPL	10	37.0	5/24/99	4.2	4.2	0.04	0.3	0.3	3.9	2.15E-8
2	DNAPL	10	36.4	5/25/99	2.5	6.7	0.06	-0.4	-0.1	6.8	9.07E-9
3	DNAPL	10	36.5	5/26/99	0.9	7.6	0.07	-0.1	-0.2	7.8	4.94E-9
4	DNAPL	10	36.3	5/27/99	0.5	8.2	0.08	-0.2	-0.4	8.6	9.33E-10
5	DNAPL	10	47.1	5/28/99	2.1	10.3	0.10	-0.3	-0.8	11.1	1.48E-9
6	DNAPL	10	47.3	6/1/99	1.6	11.9	0.11	-0.1	-0.9	12.8	1.72E-9

Test failed due to membrane disintegration on influent end

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 3808E06011 | BORING: Composite | Test No.: P5675

Project Name: DETREX | BENTONITE: Barakade 90 3% dry

Specimen - Apparatus set-up - Test Information | Cell No. 4 | Apparatu 3 | Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.688	in	Lo=	6.826	cm
dLc=	0.144	in	Ao =	42.22	cm2
Lc=	2.544	in	Vo =	288.22	cm3
			Lc=	6.461	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	46.33	cm3
			Vc =	241.89	cm3
Sc =	0.173	cm-1	Ac=	37.440	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or			top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used		Tap		Distilled			
or MIX WATER		Demineralized		0.005 N calcium sulfate (CaSO4)			Permeability

Equations Used

Kt = - 0.0000756 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.316

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	Time min	Time sec	Initial sc psi	Initial Ub psi	U-tube Reading Head (cm)	U-tube Reading Tail (cm)	Flow in/out gradient	Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.6	05/19/1999	11	50	00	110.0	100.0	62.45	48.40	1.01	4.79E-08
final	21.5	05/19/1999	12	44	00			60.53	49.00		4.59E-08
1	RT = 0.967	dT =		54.00 min		s'c =	1.4 ksf	0.144	0.142	io= 27.3	0%
initial	21.5	05/19/1999	12	45	00	110.0	100.0	62.02	48.52	1.02	4.86E-08
final	21.5	05/19/1999	13	29	00			60.47	49.00		4.66E-08
2	RT = 0.968	dT =		44.00 min		s'c =	1.4 ksf	0.116	0.114	io= 26.3	1%
initial	21.5	05/19/1999	13	31	00	110.0	100.0	62.60	48.33	0.99	4.82E-08
final	21.4	05/19/1999	14	34	00			60.35	49.05		4.63E-08
3	RT = 0.969	dT =		63.00 min		s'c =	1.4 ksf	0.169	0.171	io= 27.8	1%
initial	21.4	05/19/1999	14	36	00	110.0	100.0	62.70	48.30	1.03	4.67E-08
final	21.4	05/19/1999	16	32	00			58.98	49.44		4.50E-08
4	RT = 0.970	dT =		116.00 min		s'c =	1.4 ksf	0.279	0.271	io= 28.0	-2%

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.461	cm	ξιαλ =	5.4%
Ac =	37.760	cm2		
Vc=	243.95	cm3	εωολ =	15.4%
Sc =	0.171	cm-1	Sc = Lc / Ac , final	

	w (%)	γτ (pcf)	γδ (pcf)	S (%)
Initial	40.16	114.3	81.6	100.0
PreTest	28.41	123.8	96.4	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **4.59E-08** cm/sec

(io)ave = 27.4

Tested By: BB Reviewed By: G. Thomas

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or					
	x	with stones or		Stones with filter paper or		top + bottom			
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination					
5) Direction of permeant :	x	Up during or		Down during permeation					
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes			
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only			
6) Permeant used :		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)	
or ___DNAPL									

Stage No.:	4	sc	110.0	psi	System: p=pipette, a = annulus, b =both				
Apparatus No.	1	Ub	100.0	psi	Head Tube Area =	p	0.9883	cm2	
Cell No.	4	)max=	10.0 psi	'c)min= 6.6 psi	s'c)av= 8.3 psi	Tail Tube Area =	p	0.9931	cm2

Preliminary Length/A

Lo =	2.688
dLc=	0.144
Lc=	2.544
Lo=	6.826
Ao =	42.22
Vo =	288.22
Lc=	6.461
dVc = 3 Vo * (dLc/L	
dVc=	46.33
Vc =	241.889
Ac=	37.440

Trial No.	Stage	Temp. ° C	Time Day	hour	minute	second	Pressure Head Reading Mercury (inch)	Gage (psi)	Fluid Head Reading Head (cm)/cc	Tail (cm)/cc	Flow Ratio in/out	Total Head (cm H2O) gradient	Permeability (cm/sec) Preliminary Final at 20°C Dev. from Ave
1	I	19.8	05/24/1999	20	28	0		3.00	0.85	24.60		239.03	2.16E-08
	F	20.2	05/25/1999	17	50	0		3.10	5.10	24.25		234.43	2.15E-08
		Rt= 1.005	dT =	1282.00 min				3.05	4.20 cc	0.35 cc	12.08	io =37.0	848%
2	I	20.2	05/25/1999	18	8	0		3.00	0.70	24.25		235.30	9.15E-09
	F	20.2	05/26/1999	17	23	30		3.00	3.25	24.70		233.20	9.07E-09
		Rt= 1.000	dT =	1395.50 min				3.00	2.52 cc	-0.45 cc	-5.64	io =36.4	300%
3	I	20.2	05/26/1999	17	28	0		3.00	0.50	24.50		235.75	5.00E-09
	F	20.5	05/27/1999	9	36	0		3.00	1.40	24.60		234.95	4.94E-09
		Rt= 0.996	dT =	968.00 min				3.00	0.89 cc	-0.10 cc	-8.96	io =36.5	118%
4	I	20.5	05/27/1999	9	44	0		3.00	0.45	22.95		234.25	9.42E-10
	F	20.0	05/28/1999	18	1	0		3.00	1.00	23.20		233.95	9.33E-10
		Rt= 0.998	dT =	1937.00 min				3.00	0.54 cc	-0.25 cc	-2.19	io =36.3	-59%
5	I	20.0	05/28/1999	18	4	0		4.00	1.00	23.20		304.54	1.46E-09
	F	18.3	06/01/1999	18	45	0		4.00	3.15	23.55		302.74	1.48E-09
		Rt= 1.025	dT =	5801.00 min				4.00	2.12 cc	-0.35 cc	-6.11	io =47.1	-35%
6	I	18.3	06/01/1999	18	47	0		4.00	0.35	23.55		305.54	1.69E-09
	F	20.0	06/04/1999	18	10	0		4.00	2.00	23.65		303.99	1.72E-09
		Rt= 1.025	dT =	4283.00 min				4.00	1.63 cc	-0.10 cc	-16.42	io =47.3	-24%

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.461 cm εαξιαλ =

Ac = 37.760 cm2

Vc= 243.95 cm3 εωολ =

	w (%)	γτ (pcf)	γδ (pcf)
Initial	40.16	114.3	81.6
PreTest	28.41	123.8	96.4

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 3-6

ave K @ 20 °C: **2.27E-09** cm/sec

(io)ave = 41.79

Tested By: BB Reviewed By:

BORING: Composite

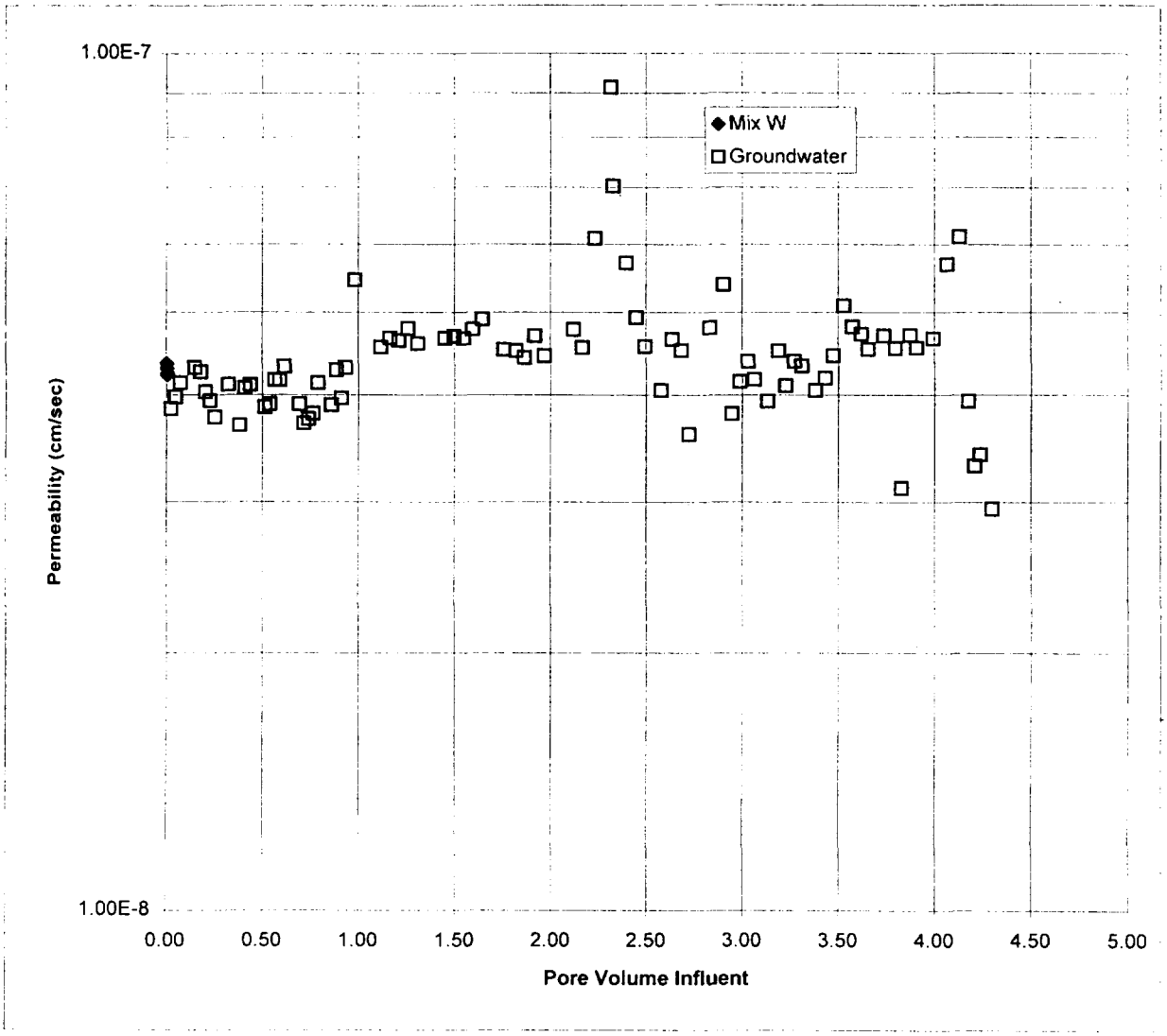
BENTONITE: Barakade 90 3% dry

Project No. 3808E06011

Project Name: DETREX

Project No. 38-08E06011
Project Name: Detrex
Boring No. Composite
Sample No. SW-101
+3% dry

Test No.: Compsum1



PERMEABILITY TEST SUMMARY
ASTM D5084

Project No. 38-08E06011
Project Name: Detrex

Boring No. Composite
Sample No. SW-101
+3% dry

Test No.: P5329.xls
Volume Voids 98.5 cm^3

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
1	Tap	20.4	03/11/1999	0.2	0.2	0.00	0.2	0.2	0.0	8.76E-8
2	Tap	20.5	03/11/1999	0.1	0.3	0.00	0.1	0.3	0.0	6.39E-8
3	Tap	20.4	03/11/1999	0.1	0.5	0.00	0.1	0.5	0.0	5.82E-8
4	Tap	20.5	03/11/1999	0.1	0.6	0.01	0.1	0.6	0.0	5.72E-8
5	Tap	20.7	03/11/1999	0.2	0.8	0.01	0.2	0.8	0.0	5.35E-8
1	Tap	20.4	03/12/1999	0.1	0.9	0.01	0.1	0.9	0.0	4.72E-8
2	Tap	20.8	03/12/1999	0.1	1.0	0.01	0.1	1.0	0.0	4.53E-8
3	Tap	21.0	03/12/1999	0.1	1.1	0.01	0.1	1.1	0.0	4.44E-8
4	Tap	20.5	03/12/1999	0.1	1.2	0.01	0.1	1.2	0.0	4.42E-8
1	Mix Water	19.8	03/15/1999	0.1	0.1	0.00	0.1	0.1	0.0	4.29E-8
2	Mix Water	20.3	03/15/1999	0.2	0.3	0.00	0.2	0.3	0.0	4.35E-8
3	Mix Water	20.3	03/15/1999	0.2	0.5	0.00	0.2	0.5	0.0	4.22E-8
4	Mix Water	20.5	03/15/1999	0.2	0.6	0.01	0.2	0.6	0.0	4.24E-8
1	Impacted GW	22.4	03/16/1999	2.3	2.3	0.02	3.0	3.0	-0.7	3.85E-8
2	Impacted GW	21.7	03/17/1999	2.4	4.7	0.05	2.7	5.7	-1.0	3.97E-8
3	Impacted GW	22.0	03/18/1999	2.5	7.2	0.07	2.5	8.3	-1.1	4.13E-8
4	Impacted GW	22.5	03/19/1999	7.5	14.7	0.15	7.6	15.9	-1.2	4.30E-8
5	Impacted GW	21.0	03/22/1999	2.9	17.6	0.18	3.4	19.3	-1.7	4.25E-8
6	Impacted GW	20.9	03/23/1999	2.5	20.1	0.20	2.5	21.8	-1.7	4.03E-8
7	Impacted GW	20.9	03/24/1999	2.4	22.5	0.23	2.4	24.2	-1.7	3.93E-8
8	Impacted GW	20.9	03/25/1999	2.4	25.0	0.25	2.4	26.6	-1.6	3.77E-8
9	Impacted GW	21.4	03/26/1999	6.9	31.9	0.32	7.0	33.6	-1.7	4.11E-8
10	Impacted GW	21.5	03/29/1999	5.8	37.7	0.38	5.6	39.2	-1.5	3.68E-8
11	Impacted GW	21.4	03/31/1999	2.7	40.4	0.41	2.9	42.1	-1.7	4.07E-8
12	Impacted GW	21.0	04/01/1999	2.8	43.2	0.44	2.8	44.9	-1.7	4.11E-8
13	Impacted GW	21.5	04/02/1999	7.5	50.7	0.52	7.6	52.5	-1.8	3.87E-8
14	Impacted GW	20.4	04/05/1999	2.5	53.2	0.54	2.4	55.0	-1.7	3.90E-8
15	Impacted GW	20.9	04/06/1999	2.5	55.8	0.57	2.7	57.6	-1.9	4.16E-8
16	Impacted GW	20.9	04/07/1999	2.4	58.2	0.59	2.4	60.0	-1.8	4.16E-8
17	Impacted GW	20.9	04/08/1999	2.6	60.8	0.62	2.6	62.6	-1.8	4.31E-8
18	Impacted GW	22.0	04/09/1999	7.5	68.3	0.69	7.4	70.0	-1.7	3.90E-8
19	Impacted GW	20.4	04/12/1999	2.3	70.6	0.72	2.3	72.4	-1.8	3.71E-8
20	Impacted GW	20.9	04/13/1999	2.4	73.0	0.74	2.3	74.7	-1.7	3.75E-8
21	Impacted GW	20.4	04/14/1999	2.3	75.3	0.76	2.3	77.0	-1.6	3.80E-8
22	Impacted GW	20.9	04/15/1999	2.4	77.8	0.79	2.5	79.5	-1.7	4.13E-8
23	Impacted GW	20.9	04/16/1999	6.9	84.7	0.86	6.9	86.4	-1.7	3.89E-8
24	Impacted GW	20.9	04/19/1999	2.5	87.3	0.89	2.6	89.0	-1.8	4.27E-8
25	Impacted GW	20.9	04/20/1999	2.4	89.7	0.91	2.4	91.4	-1.7	3.96E-8

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
26	Impacted GW	20.9	04/21/1999	2.3	92.0	0.93	2.4	93.8	-1.8	4.30E-8
27	Impacted GW	30.6	04/22/1999	4.8	96.8	0.98	4.9	98.7	-1.9	5.45E-8
28	Impacted GW	36.1	04/23/1999	13.4	110.2	1.12	13.4	112.1	-1.9	4.54E-8
29	Impacted GW	36.0	04/26/1999	4.6	114.8	1.17	4.6	116.7	-1.9	4.66E-8
30	Impacted GW	36.0	04/27/1999	4.6	119.4	1.21	4.6	121.4	-2.0	4.63E-8
31	Impacted GW	36.0	04/28/1999	4.7	124.1	1.26	4.7	126.1	-2.0	4.78E-8
32	Impacted GW	36.0	04/29/1999	5.0	129.1	1.31	5.1	131.2	-2.1	4.59E-8
33	Impacted GW	36.0	04/30/1999	14.0	143.1	1.45	13.8	145.0	-1.9	4.65E-8
34	Impacted GW	35.9	05/03/1999	4.7	147.8	1.50	4.6	149.6	-1.8	4.68E-8
35	Impacted GW	36.0	05/04/1999	4.8	152.7	1.55	4.9	154.5	-1.9	4.65E-8
36	Impacted GW	36.0	05/05/1999	4.6	157.2	1.60	4.6	159.2	-1.9	4.77E-8
37	Impacted GW	36.0	05/06/1999	4.8	162.1	1.65	4.8	164.0	-1.9	4.90E-8
38	Impacted GW	35.4	05/07/1999	11.2	173.3	1.76	11.5	175.4	-2.1	4.52E-8
39	Impacted GW	36.0	05/10/1999	6.2	179.6	1.82	6.3	181.7	-2.2	4.50E-8
40	Impacted GW	36.0	05/11/1999	4.2	183.8	1.87	4.2	186.0	-2.2	4.42E-8
41	Impacted GW	39.2	05/12/1999	5.3	189.1	1.92	5.4	191.4	-2.2	4.69E-8
42	Impacted GW	36.0	05/13/1999	4.9	194.1	1.97	5.0	196.3	-2.3	4.44E-8
43	Impacted GW	37.6	05/14/1999	14.9	209.0	2.12	15.2	211.5	-2.5	4.77E-8
44	Impacted GW	36.0	05/17/1999	4.5	213.6	2.17	4.6	216.1	-2.6	4.54E-8
45	Impacted GW	36.0	05/18/1999	6.5	220.1	2.24	6.0	222.1	-2.1	6.10E-8
46	Impacted GW	36.0	05/19/1999	8.2	228.3	2.32	9.7	231.8	-3.5	9.13E-8
47	Impacted GW	25.2	05/24/1999	0.9	229.3	2.33	0.9	232.7	-3.4	7.02E-8
1	Impacted GW	34.8	05/25/1999	7.0	236.3	2.40	6.7	239.5	-3.2	5.71E-8
2	Impacted GW	36.8	05/26/1999	5.1	241.4	2.45	5.1	244.6	-3.2	4.92E-8
3	Impacted GW	37.4	05/27/1999	4.5	245.9	2.50	4.6	249.1	-3.2	4.56E-8
4	Impacted GW	23.5	05/28/1999	8.0	254.0	2.58	8.1	257.3	-3.3	4.05E-8
5	Impacted GW	35.2	06/01/1999	5.8	259.7	2.64	5.7	263.0	-3.2	4.65E-8
6	Impacted GW	35.7	06/02/1999	4.7	264.5	2.69	4.7	267.7	-3.2	4.51E-8
7	Impacted GW	37.2	06/03/1999	3.7	268.2	2.72	3.7	271.4	-3.2	3.60E-8
8	Impacted GW	35.2	06/04/1999	10.8	279.1	2.83	10.8	282.1	-3.1	4.79E-8
9	Impacted GW	37.4	06/07/1999	6.9	286.0	2.90	7.0	289.1	-3.1	5.38E-8
10	Impacted GW	35.1	06/08/1999	4.2	290.2	2.95	4.1	293.2	-3.0	3.80E-8
11	Impacted GW	35.2	06/09/1999	4.1	294.3	2.99	4.1	297.3	-2.9	4.15E-8
12	Impacted GW	35.2	06/10/1999	4.2	298.6	3.03	4.2	301.4	-2.9	4.37E-8
13	Impacted GW	35.3	06/11/1999	3.1	301.7	3.06	3.1	304.6	-2.9	4.17E-8
14	Impacted GW	34.9	06/12/1999	6.8	308.5	3.13	6.8	311.4	-2.9	3.93E-8
15	Impacted GW	35.3	06/14/1999	5.7	314.2	3.19	5.7	317.0	-2.9	4.50E-8
16	Impacted GW	35.2	06/15/1999	3.7	317.9	3.23	3.7	320.7	-2.8	4.10E-8
17	Impacted GW	35.3	06/16/1999	4.5	322.4	3.27	4.6	325.3	-2.9	4.37E-8
18	Impacted GW	35.3	06/17/1999	3.7	326.2	3.31	3.8	329.0	-2.9	4.32E-8
19	Impacted GW	35.2	06/18/1999	6.9	333.1	3.38	6.9	336.0	-2.9	4.04E-8
20	Impacted GW	34.6	06/20/1999	5.0	338.1	3.43	5.0	340.9	-2.9	4.18E-8
21	Impacted GW	35.3	06/21/1999	4.4	342.4	3.48	4.4	345.3	-2.9	4.44E-8
22	Impacted GW	35.2	06/22/1999	5.1	347.6	3.53	5.1	350.4	-2.8	5.08E-8
23	Impacted GW	35.3	06/23/1999	4.6	352.2	3.58	4.6	355.0	-2.8	4.80E-8
24	Impacted GW	35.3	06/24/1999	4.6	356.7	3.62	4.5	359.5	-2.8	4.71E-8
25	Impacted GW	35.2	06/25/1999	3.5	360.3	3.66	3.6	363.1	-2.8	4.52E-8
26	Impacted GW	35.3	06/26/1999	7.9	368.2	3.74	7.9	371.0	-2.8	4.69E-8

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
27	Impacted GW	35.2	06/28/1999	5.9	374.1	3.80	6.0	377.0	-2.8	4.53E-8
28	Impacted GW	35.3	06/29/1999	3.0	377.1	3.83	2.9	379.9	-2.8	3.11E-8
30	Impacted GW	35.1	07/01/1999	4.5	381.6	3.88	4.6	384.5	-2.9	4.69E-8
31	Impacted GW	35.3	07/02/1999	3.4	385.0	3.91	3.4	387.9	-2.9	4.54E-8
32	Impacted GW	35.3	07/03/1999	8.5	393.5	4.00	8.4	396.3	-2.9	4.65E-8
33	Impacted GW	35.2	07/05/1999	7.1	400.5	4.07	7.5	403.8	-3.3	5.68E-8
34	Impacted GW	35.2	07/06/1999	6.3	406.8	4.13	6.0	409.8	-3.0	6.13E-8
35	Impacted GW	35.3	07/07/1999	4.5	411.3	4.18	4.4	414.3	-3.0	3.93E-8
36	Impacted GW	35.3	07/08/1999	3.3	414.6	4.21	3.3	417.6	-3.0	3.31E-8
37	Impacted GW	35.3	07/09/1999	2.8	417.5	4.24	2.8	420.4	-3.0	3.41E-8
38	Impacted GW	35.2	07/10/1999	6.2	423.6	4.30	6.2	426.6	-3.0	2.95E-8

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 | SAMPLE: Composite | Test No.: P5329

Project Name: Detrex | BENTONITE: | PERCENT: +3% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-8 | Appara 3 | Stage No.: 4

Preliminary Length/Area Calculations

Lo =	2.715	in	Lo=	6.896	cm
dLc=	0.135	in	Ao =	42.30	cm2
Lc=	2.580	in	Vo =	291.71	cm3
			Lc=	6.553	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	43.52	cm3
			Vc =	248.20	cm3
Sc =	0.173	cm-1	Ac=	37.874	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes			
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used		Tap		Distilled			
or Mix W		Demineralized		0.005 N calcium sulfate (CaSO4)			

Equations Used

Kt = - 0.0000756 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.316

Consol Stage-Trial No.	Temp. °C	Date	Time hr	Time min	Time sec	Initial sc psi	Initial Ub psi	U-tube Reading Head (cm) (cc)	U-tube Reading Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.4	03/15/1999	09	26	00	105.0	100.0	59.60	49.29	1.01	3.99E-08
final	21.4	03/15/1999	10	51	00			57.81	49.85		4.29E-08
1	RT = 0.970	dT = 85.00 min				s'c =	0.7 ksf	0.134	0.133	io= 19.8	0%
initial	21.4	03/15/1999	10	58	00	105.0	100.0	59.80	49.24	1.04	4.04E-08
final	21.4	03/15/1999	12	45	00			57.54	49.93		4.35E-08
2	RT = 0.970	dT = 107.00 min				s'c =	0.7 ksf	0.170	0.164	io= 20.3	2%
initial	21.4	03/15/1999	12	48	00	105.0	100.0	59.80	49.24	1.00	3.92E-08
final	21.4	03/15/1999	14	28	00			57.72	49.90		4.22E-08
3	RT = 0.970	dT = 100.00 min				s'c =	0.7 ksf	0.156	0.157	io= 20.3	-1%
initial	21.4	03/15/1999	14	30	00	105.0	100.0	59.88	49.21	1.03	3.94E-08
final	21.4	03/15/1999	16	33	00			57.37	49.98		4.24E-08
4	RT = 0.970	dT = 123.00 min				s'c =	0.7 ksf	0.188	0.183	io= 20.5	-1%
								0.000	0.000		

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.553	cm	ξιαλ =	5.0%	
Ac =	34.163	cm2			
Vc=	223.88	cm3	εϖολ =	23.3%	
Sc =	0.192	cm-1	Sc = Lc / Ac , final		

	w (%)	γτ (pcf)	γδ (pcf)	S (%)
Initial	47.67	109.0	73.8	98.9
PreTest	28.55	123.6	96.2	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **4.28E-08** cm/sec

(io)ave = 20.2

Tested By: DT Reviewed By: G. Thomas

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-8					22				
Stage No.:	4	sc	105.0	psi	System:	p=pipette	a = annulus	b =both		
Apparatus No.	3	Ub	100.0	psi	Head Tube Area =	0.9984	3.6792	4.6479	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi	s'c)av= 4.0 psi			Tail Tube Area =	0.9982	3.5761	4.5659	cm2	cm2

Trial No.	Stage	Temp. ° C	Time Day	hour	minute	second	Pressure Head Reading Mercury (inch)	Gage (psi)	Fluid Head Reading Head (cm)/cc	Tail (cm)/cc	Burette Flow Ratio in/out	Total Head (cm H2O) gradient	Permeability (cm/sec) Preliminary Final at 20°C Dev. from Ave
1	I	21.0	03/16/1999	17	31	0		1.60	23.45	0.15	p	146.82	3.54E-08
	F	20.8	03/17/1999	18	42	0		1.90	21.15	3.20	p	141.47	3.85E-08
		Rt= 0.983	dT =	1511.00 min				1.75	2.30 cc	3.04 cc	0.75	io =22.4	-7%
2	I	20.8	03/17/1999	18	47	0		1.60	23.40	0.90	p	142.49	3.63E-08
	F	20.7	03/18/1999	18	51	0		1.80	21.00	3.60	p	137.39	3.97E-08
		Rt= 0.986	dT =	1444.00 min				1.70	2.40 cc	2.70 cc	0.89	io =21.7	-5%
3	I	20.7	03/18/1999	18	53	0		1.60	24.50	0.45	p	144.04	3.76E-08
	F	20.4	03/19/1999	17	40	0		1.80	22.00	3.00	p	138.99	4.13E-08
		Rt= 0.991	dT =	1367.00 min				1.70	2.50 cc	2.55 cc	0.98	io =22.0	-1%
4	I	20.4	03/19/1999	17	47	0		1.60	24.50	0.30	p	147.72	3.93E-08
	F	21.0	03/22/1999	11	39	0		1.90	17.00	7.90	p	132.62	4.30E-08
		Rt= 0.987	dT =	3952.00 min				1.75	7.49 cc	7.59 cc	0.99	io =22.5	3%
5	I	21.0	03/22/1999	11	44	0		1.60	24.80	0.25	p	137.48	3.88E-08
	F	20.4	03/23/1999	16	42	0		1.60	21.90	3.65	p	131.18	4.25E-08
		Rt= 0.987	dT =	1738.00 min				1.60	2.90 cc	3.39 cc	0.85	io =21.0	2%

TEST

Final Specimen

Lc = 6.553

Ac = 34.163

Vc= 223.88

w

(%)

Initial 47.67

PreTest 28.55

HYDRAULIC CON

Averages for trials:

ave K @ 20 °C:

(io)ave =

Tested By: R

SAMPLE: Composite

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:					x	No	Yes
4) During consolidation:	x	Top and bottom drainage or				Top	Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No. H-8 — 22

Stage No.: 4 — sc 105.0 psi — System: p=pipette a = annulus b =both

Apparatus No. 3 — Ub 100.0 psi — Head Tube Area = 0.9984 3.6792 4.6479 cm2 cm2

(s'c)max= 5.0 psi (s'c)min= 2.9 psi s'c)av= 4.0 psi — Tail Tube Area = 0.9982 3.5761 4.5659 cm2 cm2

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
6	I	20.4	03/23/1999	16	44	0		1.60	24.70	0.35	p	137.28	3.67E-08
	F	20.8	03/24/1999	16	58	0		1.60	22.20	2.85	p	132.28	4.03E-08
		Rt= 0.990	dT =	1454.00 min				1.60	2.50 cc	2.50 cc	1.00	io =20.9	-3%
7	I	20.8	03/24/1999	17	2	0		1.60	24.55	0.35	p	137.13	3.62E-08
	F	21.1	03/25/1999	17	10	0		1.60	22.10	2.80	p	132.23	3.93E-08
		Rt= 0.981	dT =	1448.00 min				1.60	2.45 cc	2.45 cc	1.00	io =20.9	-5%
8	I	21.1	03/25/1999	17	12	0		1.60	24.55	0.50	p	136.98	3.53E-08
	F	22.3	03/26/1999	17	43	0		1.60	22.10	2.90	p	132.13	3.77E-08
		Rt= 0.963	dT =	1471.00 min				1.60	2.45 cc	2.40 cc	1.02	io =20.9	-10%
9	I	22.3	03/26/1999	17	55	0		1.60	24.85	0.80	p	140.51	3.88E-08
	F	21.7	03/29/1999	10	31	0		1.70	17.90	7.80	p	126.56	4.11E-08
		Rt= 0.956	dT =	3876.00 min				1.65	6.94 cc	6.99 cc	0.99	io =21.4	-1%
10	I	21.7	03/29/1999	10	35	0		1.60	24.70	0.30	p	140.86	3.66E-08
	F	26.2	03/31/1999	18	8	0		1.70	18.90	5.95	p	129.41	3.68E-08
		Rt= 0.908	dT =	3333.00 min				1.65	5.79 cc	5.64 cc	1.03	io =21.5	-11%
11	I	26.2	03/31/1999	18	13	0		1.60	24.60	0.50	p	140.56	4.10E-08
	F	22.6	04/01/1999	18	2	0		1.70	21.90	3.40	p	134.96	4.07E-08
		Rt= 0.897	dT =	1429.00 min				1.65	2.70 cc	2.89 cc	0.93	io =21.4	-2%

TEST

Final Specimen

Lc = 6.553

BENTONITE: SW-101

Project No. 38-08E060

Project Name: Detrex

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or				
	x	with stones or		Stones with filter paper or		top + bottom		
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination				
5) Direction of permeant :	x	Up during or		Down during permeation				
3) During saturation: Water flushed up sides of specimen to remove air:					x	No		Yes
4) During consolidation:	x	Top and bottom drainage or				Top		Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)

Cell No.	H-8				22					
Stage No.:	4	sc	105.0	psi	System: p=pipette a = annulus b =both					
Apparatus No.	3	Ub	100.0	psi	Head Tube Area =	0.9984	3.6792	4.6479	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi	s'c)av= 4.0 psi			Tail Tube Area =	0.9982	3.5761	4.5659	cm2	cm2

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
12	I	22.6	04/01/1999	18	6	0		1.60	24.80	0.40	p	137.33	3.97E-08
	F	23.2	04/02/1999	19	16	0		1.60	22.00	3.20	p	131.73	4.11E-08
		Rt= 0.933	dT =	1510.00	min			1.60	2.80 cc	2.79 cc	1.00	io =21.0	-1%
13	I	23.2	04/02/1999	17	18	0		1.60	24.50	0.35	p	140.61	3.77E-08
	F	23.3	04/05/1999	17	47	0		1.70	16.95	7.95	p	125.46	3.87E-08
		Rt= 0.925	dT =	4349.00	min			1.65	7.54 cc	7.59 cc	0.99	io =21.5	-7%
14	I	23.3	04/05/1999	18	51	0		1.60	24.75	0.45	p	133.71	3.77E-08
	F	22.5	04/06/1999	18	52	0		1.50	22.25	2.90	p	128.76	3.90E-08
		Rt= 0.933	dT =	1441.00	min			1.55	2.50 cc	2.45 cc	1.02	io =20.4	-6%
15	I	22.5	04/06/1999	18	55	0		1.60	24.75	0.45	p	137.23	3.85E-08
	F	19.8	04/07/1999	19	15	0		1.60	22.20	3.15	p	131.98	4.16E-08
		Rt= 0.976	dT =	1460.00	min			1.60	2.55 cc	2.70 cc	0.94	io =20.9	0%
16	I	19.8	04/07/1999	19	18	0		1.60	24.55	0.40	p	137.08	3.76E-08
	F	20.7	04/08/1999	18	18	0		1.60	22.10	2.80	p	132.23	4.16E-08
		Rt= 0.998	dT =	1380.00	min			1.60	2.45 cc	2.40 cc	1.02	io =20.9	0%
17	I	20.7	04/08/1999	18	21	0		1.60	24.65	0.40	p	137.18	3.92E-08
	F	20.3	04/09/1999	18	0	0		1.60	22.05	3.00	p	131.98	4.31E-08
		Rt= 0.992	dT =	1419.00	min			1.60	2.60 cc	2.60 cc	1.00	io =20.9	4%
18	I	20.3	04/09/1999	18	2	0		1.60	24.75	0.35	p	144.39	3.61E-08

TEST
Final Specimen
Lc = 6.553

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-8					22				
Stage No.:	4	sc	105.0	psi	System: p=pipette a = annulus b =both					
Apparatus No.	3	Ub	100.0	psi	Head Tube Area =	0.9984	3.6792	4.6479	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi	s'c)av= 4.0 psi			Tail Tube Area =	0.9982	3.5761	4.5659	cm2	cm2

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary / Final at 20°C
	F	22.2	04/12/1999	18	21	0		1.80	17.25	7.75	p	129.49	3.90E-08
		Rt= 0.974	dT =	4339.00 min				1.70	7.49 cc	7.39 cc	1.01	io =22.0	-6%
19	I	22.2	04/12/1999	18	24	0		1.60	24.60	0.45	p	133.56	3.56E-08
	F	23.1	04/13/1999	18	18	0		1.50	22.30	2.80	p	128.91	3.71E-08
		Rt= 0.940	dT =	1434.00 min				1.55	2.30 cc	2.35 cc	0.98	io =20.4	-11%
20	I	23.1	04/13/1999	18	21	0		1.60	24.50	0.40	p	137.03	3.51E-08
	F	20.3	04/14/1999	18	12	0		1.60	22.10	2.70	p	132.33	3.75E-08
		Rt= 0.963	dT =	1431.00 min				1.60	2.40 cc	2.30 cc	1.04	io =20.9	-10%
21	I	20.3	04/14/1999	18	16	0		1.60	24.50	0.35	p	133.56	3.57E-08
	F	23.2	04/15/1999	18	6	0		1.50	22.15	2.65	p	128.91	3.80E-08
		Rt= 0.962	dT =	1430.00 min				1.55	2.35 cc	2.30 cc	1.02	io =20.4	-9%
22	I	23.2	04/15/1999	18	8	0		1.60	24.60	0.50	p	137.03	3.83E-08
	F	19.5	04/16/1999	17	10	0		1.60	22.15	3.00	p	132.08	4.13E-08
		Rt= 0.971	dT =	1382.00 min				1.60	2.45 cc	2.50 cc	0.98	io =20.9	-1%
23	I	19.5	04/16/1999	17	13	0		1.60	24.55	0.35	p	137.13	3.56E-08
	F	22.1	04/19/1999	17	10	0		1.60	17.60	7.30	p	123.23	3.89E-08
		Rt= 0.985	dT =	4317.00 min				1.60	6.94 cc	6.94 cc	1.00	io =20.9	-7%
24	I	22.1	04/19/1999	17	13	0		1.60	24.60	0.50	p	137.03	3.87E-08
	F	18.6	04/20/1999	17	12	0		1.60	22.05	3.15	p	131.83	4.27E-08

TEST

Final Specimen

Lc = 6.553

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or				
	x	with stones or		Stones with filter paper or		top + bottom		
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination				
5) Direction of permeant :	x	Up during or		Down during permeation				
3) During saturation: Water flushed up sides of specimen to remove air:					x	No		Yes
4) During consolidation:	x	Top and bottom drainage or				Top		Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)

Cell No.	H-8					22					
Stage No.:	4	sc	105.0	psi	System: p=pipette a = annulus b =both						
Apparatus No.	3	Ub	100.0	psi	Head Tube Area =	0.9984	3.6792	4.6479	cm2	cm2	
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi	s'c)av= 4.0 psi			Tail Tube Area =	0.9982	3.5761	4.5659	cm2	cm2	

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
		Rt= 0.996	dT =	1439.00 min				1.60	2.55 cc	2.65 cc	0.96	io =20.9	3%
25	I	18.6	04/20/1999	17	14	0		1.60	24.65	0.50	p	137.08	3.59E-08
	F	22.2	04/21/1999	17	18	0		1.60	22.20	2.90	p	132.23	3.96E-08
		Rt= 0.995	dT =	1444.00 min				1.60	2.45 cc	2.40 cc	1.02	io =20.9	-5%
26	I	22.2	04/21/1999	17	20	0		1.60	24.60	0.40	p	137.13	4.00E-08
	F	20.7	04/22/1999	14	14	0		1.60	22.30	2.80	p	132.43	4.30E-08
		Rt= 0.969	dT =	1254.00 min				1.60	2.30 cc	2.40 cc	0.96	io =20.9	3%
27	I	20.7	04/22/1999	15	53	0		3.00	24.65	0.90	p	200.21	4.91E-08
	F	19.6	04/23/1999	16	9	0		2.00	19.85	5.80	p	190.51	5.45E-08
		Rt= 1.001	dT =	1456.00 min				2.50	4.79 cc	4.89 cc	0.98	io =30.6	31%
28	I	19.6	04/23/1999	16	12	0		3.00	24.80	0.30	p	236.25	3.96E-08
	F	18.0	04/26/1999	17	4	0		3.00	11.40	13.70	p	209.45	4.54E-08
		Rt= 1.034	dT =	4372.00 min				3.00	13.38 cc	13.38 cc	1.00	io =36.1	9%
29	I	18.0	04/26/1999	17	7	0		3.00	24.60	0.20	p	236.15	4.06E-08
	F	19.5	04/27/1999	16	51	0		3.00	19.95	4.85	p	226.85	4.66E-08
		Rt= 1.035	dT =	1424.00 min				3.00	4.64 cc	4.64 cc	1.00	io =36.0	12%
30	I	19.5	04/27/1999	16	53	0		3.00	24.50	0.30	p	235.95	4.05E-08
	F	18.4	04/28/1999	16	34	0		3.00	19.90	4.95	p	226.70	4.63E-08
		Rt= 1.030	dT =	1421.00 min				3.00	4.59 cc	4.64 cc	0.99	io =36.0	11%

TEST
Final Specimen
Lc = 6.553

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-8				22					
Stage No.:	4	sc	105.0	psi	System:	p=pipette	a = annulus	b =both		
Apparatus No.	3	Ub	100.0	psi	Head Tube Area =	0.9984	3.6792	4.6479	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi	s'c)av= 4.0 psi			Tail Tube Area =	0.9982	3.5761	4.5659	cm2	cm2

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
31	I	18.4	04/28/1999	16	40	0		3.00	24.55	0.20	p	236.10	4.14E-08
	F	18.6	04/29/1999	16	11	0		3.00	19.85	4.90	p	226.70	4.78E-08
		Rt= 1.041	dT =	1411.00 min				3.00	4.69 cc	4.69 cc	1.00	io =36.0	15%
32	I	18.6	04/29/1999	16	14	0		3.00	24.50	0.35	p	235.90	4.03E-08
	F	19.5	04/30/1999	18	18	0		3.00	19.50	5.45	p	225.80	4.59E-08
		Rt= 1.028	dT =	1564.00 min				3.00	4.99 cc	5.09 cc	0.98	io =36.0	10%
33	I	19.5	04/30/1999	18	19	0		3.00	24.50	0.30	p	235.95	4.14E-08
	F	19.8	05/03/1999	19	10	0		3.00	10.45	14.15	p	208.05	4.65E-08
		Rt= 1.013	dT =	4371.00 min				3.00	14.03 cc	13.83 cc	1.01	io =36.0	12%
34	I	19.8	05/03/1999	19	15	0		3.00	24.40	0.60	p	235.55	4.20E-08
	F	20.0	05/04/1999	18	17	0		3.00	19.70	5.20	p	226.25	4.68E-08
		Rt= 1.007	dT =	1382.00 min				3.00	4.69 cc	4.59 cc	1.02	io =35.9	13%
35	I	20.0	05/04/1999	18	21	0		3.00	24.55	0.50	p	235.80	4.17E-08
	F	19.9	05/05/1999	18	45	0		3.00	19.70	5.45	p	226.00	4.65E-08
		Rt= 1.006	dT =	1464.00 min				3.00	4.84 cc	4.94 cc	0.98	io =36.0	12%
36	I	19.9	05/05/1999	18	49	0		3.00	24.70	0.35	p	236.10	4.12E-08
	F	19.4	05/06/1999	18	4	0		3.00	20.10	5.00	p	226.85	4.77E-08
		Rt= 1.044	dT =	1395.00 min				3.00	4.59 cc	4.64 cc	0.99	io =36.0	15%
37	I	19.4	05/06/1999	18	17	0		3.00	24.70	0.45	p	236.00	4.23E-08

TEST
Final Specimen
Lc = 6.553

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
5) Direction of permeant :	x	Up during or		Down during permeation		
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or 0.005 N calcium sulfate (CaSO4)

Cell No.	H-8					22				
Stage No.:	4	sc	105.0	psi	System:	p=pipette a = annulus b =both				
Apparatus No.	3	Ub	100.0	psi	Head Tube Area =	0.9984	3.6792	4.6479	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi	s'c)av= 4.0 psi			Tail Tube Area =	0.9982	3.5761	4.5659	cm2	cm2

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
	F	19.5	05/07/1999	17	56	0		3.00	19.85	5.25	p	226.35	4.90E-08
		Rt= 1.044	dT =	1419.00 min				3.00	4.84 cc	4.79 cc	1.01	io =36.0	18%
38	I	19.5	05/07/1999	18	0	0		3.00	24.35	0.50	p	232.07	3.90E-08
	F	21.4	05/10/1999	9	25	0		2.90	13.10	12.00	p	209.32	4.52E-08
		Rt= 1.044	dT =	3805.00 min				2.95	11.23 cc	11.48 cc	0.98	io =35.4	8%
39	I	21.4	05/10/1999	9	31	0		3.00	24.50	0.50	p	235.75	3.89E-08
	F	19.2	05/11/1999	19	15	0		3.00	18.25	6.80	p	223.20	4.50E-08
		Rt= 1.044	dT =	2024.00 min				3.00	6.24 cc	6.29 cc	0.99	io =36.0	8%
40	I	19.2	05/11/1999	19	19	0		3.00	24.50	0.50	p	235.75	4.00E-08
	F	18.5	05/12/1999	17	22	0		3.00	20.25	4.75	p	227.25	4.42E-08
		Rt= 0.997	dT =	1323.00 min				3.00	4.24 cc	4.24 cc	1.00	io =36.0	6%
41	I	18.5	05/12/1999	17	25	0		3.00	24.65	0.45	p	257.13	4.24E-08
	F	18.2	05/13/1999	17	35	0		3.60	19.30	5.85	p	246.38	4.69E-08
		Rt= 0.997	dT =	1450.00 min				3.30	5.34 cc	5.39 cc	0.99	io =39.2	13%
42	I	18.2	05/13/1999	17	39	0		3.00	24.75	0.45	p	236.05	4.01E-08
	F	20.2	05/14/1999	19	23	0		3.00	19.80	5.45	p	226.10	4.44E-08
		Rt= 0.997	dT =	1544.00 min				3.00	4.94 cc	4.99 cc	0.99	io =36.0	7%
43	I	20.2	05/14/1999	17	32	0		3.00	24.55	0.45	p	246.44	4.31E-08
	F	20.0	05/17/1999	18	8	0		3.30	9.60	15.65	p	216.29	4.77E-08

TEST

Final Specimen

Lc = 6.553

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:					x	No	Yes
4) During consolidation:	x	Top and bottom drainage or				Top	Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-8					22				
Stage No.:	4	sc	105.0	psi	System:	p=pipette	a = annulus	b =both		
Apparatus No.	3	Ub	100.0	psi	Head Tube Area =	0.9984	3.6792	4.6479	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi	s'c)av= 4.0 psi			Tail Tube Area =	0.9982	3.5761	4.5659	cm2	cm2

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary / Final at 20°C
		Rt= 0.997	dT =	4356.00 min				3.15	14.93 cc	15.17 cc	0.98	io =37.6	15%
44	I	20.0	05/17/1999	18	12	0		3.00	24.70	0.40	p	236.05	4.11E-08
	F	19.8	05/18/1999	17	17	0		3.00	20.15	5.00	p	226.90	4.54E-08
		Rt= 0.997	dT =	1385.00 min				3.00	4.54 cc	4.59 cc	0.99	io =36.0	9%
45	I	19.8	05/18/1999	17	23	0		3.00	24.45	0.45	p	235.75	5.51E-08
	F	19.3	05/19/1999	17	17	0		3.00	17.90	6.50	p	223.15	6.10E-08
		Rt= 0.997	dT =	1434.00 min				3.00	6.54 cc	6.04 cc	1.08	io =36.0	46%
46	I	19.3	05/19/1999	17	20	0		3.00	24.40	0.20	p	235.95	8.26E-08
	F	19.1	05/20/1999	16	19	0		3.00	16.15	9.90	p	218.00	9.13E-08
		Rt= 0.997	dT =	1379.00 min				3.00	8.24 cc	9.68 cc	0.85	io =36.0	119%
47	I	19.8	05/24/1999	10	50	0		2.00	24.65	0.40	p	165.42	6.35E-08
	F	8.0	05/24/1999	15	5	0		2.00	23.70	1.30	p	163.57	7.02E-08
		Rt= 0.997	dT =	255.00 min				2.00	0.95 cc	0.90 cc	1.06	io =25.2	69%

TEST
Final Specimen
Lc = 6.553

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial C
	x	with ston e
2) Specimen orientation for:	x	Vertical o
5) Direction of permeant :	x	Up during
3) During saturation: Water flushed up sides of specim		
4) During consolidation:	x	Top and b
6) Permeant used : Impacted GW		Deminera

Cell No.	H-8		
Stage No.:	4	sc	105.0
Apparatus No.	3	Ub	100.0

(s'c)max= 5.0 psi (s'c)min= 2.9 psi s'c)av=

Preliminary Length/A

Lo =	2.715
dLc=	0.135
Lc=	2.580
Lo=	6.896
Ao =	42.30
Vo =	291.71
Lc=	6.553

dVc = 3 Vo * (dLc/L

dVc=	43.52
Vc =	248.198
Ac=	37.874

Trial No.	Stage	Temp. ° C	Time Day	hour	minute
1	I	21.0	03/16/1999	17	31
	F	20.8	03/17/1999	18	42
		Rt= 0.983	dT =	1511.00 min	
2	I	20.8	03/17/1999	18	47
	F	20.7	03/18/1999	18	51
		Rt= 0.986	dT =	1444.00 min	
3	I	20.7	03/18/1999	18	53
	F	20.4	03/19/1999	17	40
		Rt= 0.991	dT =	1367.00 min	
4	I	20.4	03/19/1999	17	47
	F	21.0	03/22/1999	11	39
		Rt= 0.987	dT =	3952.00 min	
5	I	21.0	03/22/1999	11	44
	F	20.4	03/23/1999	16	42
		Rt= 0.987	dT =	1738.00 min	

SUMMARY

n and Test Conditions

cm

εαξιαλ =

cm2

cm3

εωολ =

γτ (pcf)

γδ (pcf)

109.0 73.8

123.6 96.2

NDUCTIVITY SUMMARY

2-5	
4.16E-08	cm/sec
21.81	

Reviewed By:

Specimen - Apparatus set-up - Test Information					Preliminary Length/A	
1) Specimen Tested in :		x	Triaxial C		Lo =	2.715
		x	with stone		dLc=	0.135
2) Specimen orientation for:		x	Vertical p		Lc=	2.580
5) Direction of permeant :		x	Up during		Lo=	6.896
3) During saturation: Water flushed up sides of specm					Ao =	42.30
4) During consolidation:		x	Top and b		Vo =	291.71
6) Permeant used :	Impacted GW		Demineral		Lc=	6.553
Cell No.	H-8				dVc = 3 Vo * (dLc/L	
Stage No.:	4	sc	105.0		dVc=	43.52
Apparatus No.	3	Ub	100.0		Vc =	248.198
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi		s'c)av=		Ac=	37.874

Trial	Stage	Temp.	Time			SUMMARY n and Test Conditions cm	εαξιαλ =
6	I	20.4	03/23/1999	16	44		
	F	20.8	03/24/1999	16	58	11	
		Rt= 0.990	dT =	1454.00 min			
7	I	20.8	03/24/1999	17	2		
	F	21.1	03/25/1999	17	10		
		Rt= 0.981	dT =	1448.00 min			
8	I	21.1	03/25/1999	17	12		
	F	22.3	03/26/1999	17	43		
		Rt= 0.963	dT =	1471.00 min			
9	I	22.3	03/26/1999	17	55		
	F	21.7	03/29/1999	10	31		
		Rt= 0.956	dT =	3876.00 min			
10	I	21.7	03/29/1999	10	35		
	F	26.2	03/31/1999	18	8		
		Rt= 0.908	dT =	3333.00 min			
11	I	26.2	03/31/1999	18	13		
	F	22.6	04/01/1999	18	2		
		Rt= 0.897	dT =	1429.00 min			

Specimen - Apparatus set-up - Test Information				Preliminary Length/A	
1) Specimen Tested in :	x	Triaxial C		Lo =	2.715
	x	with stone		dLc=	0.135
2) Specimen orientation for:	x	Vertical p		Lc=	2.580
5) Direction of permeant :	x	Up during		Lo=	6.896
3) During saturation: Water flushed up sides of specim				Ao =	42.30
4) During consolidation:	x	Top and b		Vo =	291.71
6) Permeant used : Impacted GW		Demineral		Lc=	6.553
Cell No.	H-8			dVc = 3 Vo * (dLc/L	
Stage No.:	4	sc	105.0	dVc=	43.52
Apparatus No.	3	Ub	100.0	Vc =	248.198
(s'c)max= 5.0 psi	(s'c)min=	2.9 psi	s'c)av=	Ac=	37.874

Trial	Stage	Temp.	Time			SUMMARY n and Test Conditions
						cm εαξιαλ =
12	I	22.6	04/01/1999	18	6	
	F	23.2	04/02/1999	19	16	
		Rt= 0.933	dT =	1510.00 min		
13	I	23.2	04/02/1999	17	18	
	F	23.3	04/05/1999	17	47	
		Rt= 0.925	dT =	4349.00 min		
14	I	23.3	04/05/1999	18	51	
	F	22.5	04/06/1999	18	52	
		Rt= 0.933	dT =	1441.00 min		
15	I	22.5	04/06/1999	18	55	
	F	19.8	04/07/1999	19	15	
		Rt= 0.976	dT =	1460.00 min		
16	I	19.8	04/07/1999	19	18	
	F	20.7	04/08/1999	18	18	
		Rt= 0.998	dT =	1380.00 min		
17	I	20.7	04/08/1999	18	21	
	F	20.3	04/09/1999	18	0	
		Rt= 0.992	dT =	1419.00 min		
18	I	20.3	04/09/1999	18	2	

Specimen - Apparatus set-up - Test Information				Preliminary Length/A	
1) Specimen Tested in :	x	Triaxial C		Lo =	2.715
	x	with stone		dLc=	0.135
2) Specimen orientation for:	x	Vertical p		Lc=	2.580
5) Direction of permeant :	x	Up during		Lo=	6.896
3) During saturation: Water flushed up sides of specim				Ao =	42.30
4) During consolidation:	x	Top and b		Vo =	291.71
6) Permeant used : Impacted GW		Demineral		Lc=	6.553
Cell No.	H-8			dVc = 3 Vo * (dLc/L	
Stage No.:	4	sc	105.0	dVc=	43.52
Apparatus No.	3	Ub	100.0	Vc =	248.198
(s'c)max= 5.0 psi	(s'c)min=	2.9 psi	s'c)av=	Ac=	37.874

Trial	Stage	Temp.	Time			SUMMARY n and Test Conditions cm εαξιαλ =
	F	22.2	04/12/1999	18	21	
		Rt= 0.974	dT =	4339.00 min		
19	I	22.2	04/12/1999	18	24	
	F	23.1	04/13/1999	18	18	
		Rt= 0.940	dT =	1434.00 min		
20	I	23.1	04/13/1999	18	21	
	F	20.3	04/14/1999	18	12	
		Rt= 0.963	dT =	1431.00 min		
21	I	20.3	04/14/1999	18	16	
	F	23.2	04/15/1999	18	6	
		Rt= 0.962	dT =	1430.00 min		
22	I	23.2	04/15/1999	18	8	
	F	19.5	04/16/1999	17	10	
		Rt= 0.971	dT =	1382.00 min		
23	I	19.5	04/16/1999	17	13	
	F	22.1	04/19/1999	17	10	
		Rt= 0.985	dT =	4317.00 min		
24	I	22.1	04/19/1999	17	13	
	F	18.6	04/20/1999	17	12	

Specimen - Apparatus set-up - Test Information				Preliminary Length/A	
1) Specimen Tested in :	x	Triaxial C		Lo =	2.715
	x	with stone		dLc=	0.135
2) Specimen orientation for:	x	Vertical p		Lc=	2.580
5) Direction of permeant :	x	Up during		Lo=	6.896
3) During saturation: Water flushed up sides of specm				Ao =	42.30
4) During consolidation:	x	Top and b		Vo =	291.71
6) Permeant used : Impacted GW		Demineral		Lc=	6.553
Cell No.	H-8			dVc = 3 Vo * (dLc/L	
Stage No.:	4	sc	105.0	dVc=	43.52
Apparatus No.	3	Ub	100.0	Vc =	248.198
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi		s'c)av=	Ac=	37.874

SUMMARY

n and Test Conditions

cm εαξιαλ =

Trial	Stage	Temp.	Time		
		Rt= 0.996	dT =	1439.00 min	
25	I	18.6	04/20/1999	17	14
	F	22.2	04/21/1999	17	18
		Rt= 0.995	dT =	1444.00 min	
26	I	22.2	04/21/1999	17	20
	F	20.7	04/22/1999	14	14
		Rt= 0.969	dT =	1254.00 min	
27	I	20.7	04/22/1999	15	53
	F	19.6	04/23/1999	16	9
		Rt= 1.001	dT =	1456.00 min	
28	I	19.6	04/23/1999	16	12
	F	18.0	04/26/1999	17	4
		Rt= 1.034	dT =	4372.00 min	
29	I	18.0	04/26/1999	17	7
	F	19.5	04/27/1999	16	51
		Rt= 1.035	dT =	1424.00 min	
30	I	19.5	04/27/1999	16	53
	F	18.4	04/28/1999	16	34
		Rt= 1.030	dT =	1421.00 min	

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial C
	x	with stone
2) Specimen orientation for:	x	Vertical p
5) Direction of permeant :	x	Up during
3) During saturation: Water flushed up sides of specm		
4) During consolidation:	x	Top and b
6) Permeant used : Impacted GW		Demineral

Cell No.	H-8		
Stage No.:	4	sc	105.0
Apparatus No.	3	Ub	100.0

(s'c)max= 5.0 psi (s'c)min= 2.9 psi s'c)av=

Preliminary Length/A

Lo =	2.715
dLc=	0.135
Lc=	2.580
Lo=	6.896
Ao =	42.30
Vo =	291.71
Lc=	6.553
dVc = 3 Vo * (dLc/L	
dVc=	43.52
Vc =	248.198
Ac=	37.874

Trial	Stage	Temp.	Time		
31	I	18.4	04/28/1999	16	40
	F	18.6	04/29/1999	16	11
		Rt= 1.041	dT =	1411.00 min	
32	I	18.6	04/29/1999	16	14
	F	19.5	04/30/1999	18	18
		Rt= 1.028	dT =	1564.00 min	
33	I	19.5	04/30/1999	18	19
	F	19.8	05/03/1999	19	10
		Rt= 1.013	dT =	4371.00 min	
34	I	19.8	05/03/1999	19	15
	F	20.0	05/04/1999	18	17
		Rt= 1.007	dT =	1382.00 min	
35	I	20.0	05/04/1999	18	21
	F	19.9	05/05/1999	18	45
		Rt= 1.006	dT =	1464.00 min	
36	I	19.9	05/05/1999	18	49
	F	19.4	05/06/1999	18	4
		Rt= 1.044	dT =	1395.00 min	
37	I	19.4	05/06/1999	18	17

SUMMARY

n and Test Conditions

cm εαξιαλ =

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial C
	x	with stone
2) Specimen orientation for:	x	Vertical p
5) Direction of permeant :	x	Up during
3) During saturation: Water flushed up sides of specim		
4) During consolidation:	x	Top and b
6) Permeant used : Impacted GW		Demineral

Cell No.	H-8		
Stage No.:	4	sc	105.0
Apparatus No.	3	Ub	100.0
(s'c)max= 5.0 psi	(s'c)min= 2.9 psi	s'c)av=	

Preliminary Length/A

Lo =	2.715
dLc=	0.135
Lc=	2.580
Lo=	6.896
Ao =	42.30
Vo =	291.71
Lc=	6.553
dVc = 3 Vo * (dLc/L	
dVc=	43.52
Vc =	248.198
Ac=	37.874

SUMMARY

n and Test Conditions

cm εαξιαλ =

Trial	Stage	Temp.	Time		
	F	19.5	05/07/1999	17	56
		Rt= 1.044	dT =	1419.00 min	
38	I	19.5	05/07/1999	18	0
	F	21.4	05/10/1999	9	25
		Rt= 1.044	dT =	3805.00 min	
39	I	21.4	05/10/1999	9	31
	F	19.2	05/11/1999	19	15
		Rt= 1.044	dT =	2024.00 min	
40	I	19.2	05/11/1999	19	19
	F	18.5	05/12/1999	17	22
		Rt= 0.997	dT =	1323.00 min	
41	I	18.5	05/12/1999	17	25
	F	18.2	05/13/1999	17	35
		Rt= 0.997	dT =	1450.00 min	
42	I	18.2	05/13/1999	17	39
	F	20.2	05/14/1999	19	23
		Rt= 0.997	dT =	1544.00 min	
43	I	20.2	05/14/1999	17	32
	F	20.0	05/17/1999	18	8

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial C	
	x	with ston	
2) Specimen orientation for:	x	Vertical p	
5) Direction of permeant :	x	Up during	
3) During saturation: Water flushed up sides of specm			
4) During consolidation:	x	Top and b	
6) Permeant used : Impacted GW		Deminera	

Cell No.	H-8		
Stage No.:	4	sc	105.0
Apparatus No.	3	Ub	100.0

(s'c)max= 5.0 psi (s'c)min= 2.9 psi s'c)av=

Preliminary Length/A

Lo =	2.715
dLc=	0.135
Lc=	2.580
Lo=	6.896
Ao =	42.30
Vo =	291.71
Lc=	6.553
dVc = 3 Vo * (dLc/L	
dVc=	43.52
Vc =	248.198
Ac=	37.874

SUMMARY

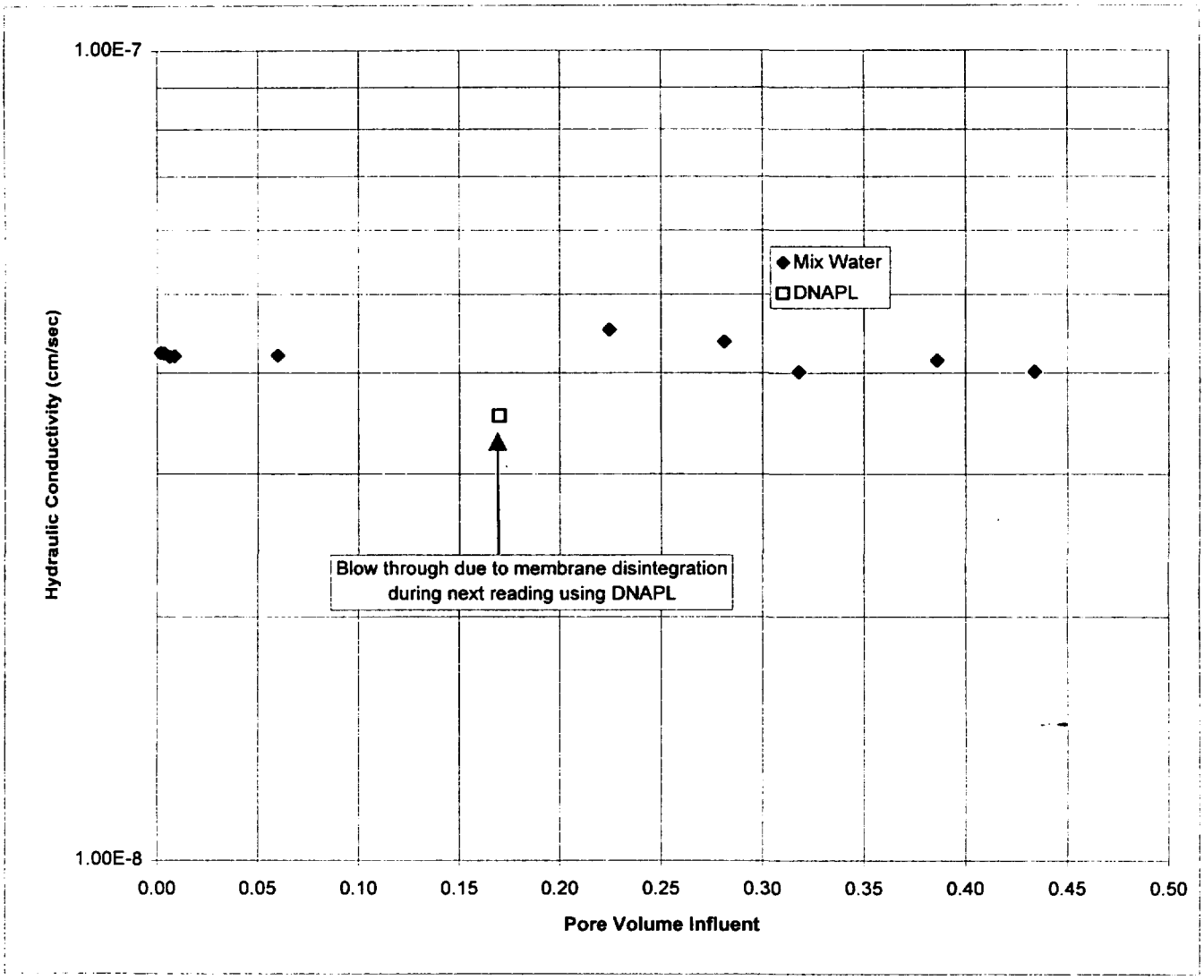
n and Test Conditions

cm εαξιαλ =

Trial	Stage	Temp.	Time		
		Rt= 0.997	dT =	4356.00 min	
44	I	20.0	05/17/1999	18	12
	F	19.8	05/18/1999	17	17
		Rt= 0.997	dT =	1385.00 min	
45	I	19.8	05/18/1999	17	23
	F	19.3	05/19/1999	17	17
		Rt= 0.997	dT =	1434.00 min	
46	I	19.3	05/19/1999	17	20
	F	19.1	05/20/1999	16	19
		Rt= 0.997	dT =	1379.00 min	
47	I	19.8	05/24/1999	10	50
	F	8.0	05/24/1999	15	5
		Rt= 0.997	dT =	255.00 min	

Project No. 3808E06011
Project Name: DETREX
Boring No. Composite
Sample No. SW101
3% dry

Test No.: Compsum1.



PERMEABILITY TEST SUMMARY
ASTM D5084

Project No. 3808E06011
Project Name: DETREX

Boring No. Composite
Sample No. SW101

Test No.: p5677.xls
Volume Voids 112.7 cm^3

					Influent			Effluent		Sum	
Stage	Permeant Type	Maximum Confining Stress (psi)	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
1	Tap	5	22.8	04/26/1999	0.1	0.1	0.00	0.1	0.1	0.0	6.72E-8
2	Tap	5	22.5	04/26/1999	0.2	0.3	0.00	0.1	0.3	0.0	6.47E-8
3	Tap	5	22.6	04/26/1999	0.3	0.6	0.00	0.3	0.6	0.0	6.05E-8
4	Tap	5	22.1	04/26/1999	0.2	0.7	0.01	0.2	0.8	0.0	6.33E-8
5	Tap	5	22.5	04/26/1999	0.2	0.9	0.01	0.2	1.0	0.0	6.25E-8
6	Tap	5	23.2	04/26/1999	0.2	1.2	0.01	0.2	1.2	0.0	5.89E-8
1	Tap	10	37.2	04/28/1999	0.2	0.2	0.00	0.2	1.4	-1.2	4.23E-8
2	Tap	10	39.0	04/28/1999	0.2	0.4	0.00	0.2	1.6	-1.2	4.23E-8
3	Tap	10	38.6	04/28/1999	0.3	0.7	0.01	0.3	1.9	-1.2	4.19E-8
4	Tap	10	39.5	04/28/1999	0.3	1.0	0.01	0.3	2.2	-1.2	4.20E-8
1	Site Mix	10	44.9	04/29/1999	6.8	6.8	0.06	5.9	5.9	0.8	4.20E-8
2	Site Mix	10	44.4	04/30/1999	18.5	25.3	0.22	17.5	23.4	1.9	4.52E-8
3	Site Mix	10	46.6	05/03/1999	6.4	31.7	0.28	5.7	29.1	2.6	4.37E-8
4	Site Mix	10	45.5	05/04/1999	4.1	35.8	0.32	3.9	33.0	2.8	4.01E-8
5	Site Mix	10	47.6	05/05/1999	7.7	43.5	0.39	7.1	40.1	3.4	4.14E-8
6	Site Mix	10	47.2	05/06/1999	5.4	48.9	0.43	5.2	45.3	3.6	4.01E-8
1	DNAPL	10	46.5	05/07/1999	19.1	19.1	0.17	7.6	7.6	11.6	3.54E-8

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or				
	x	with stones or		Stones with filter paper or		top + bottom		
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination				
5) Direction of permeant :	x	Up during or		Down during permeation				
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes		
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only		
6) Permeant used :		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)
or ___MIX WATER								

Stage No.:	4	sc	110.0	psi	System: p=pipette, a = annulus, b =both			
Apparatus No.	2	Ub	100.0	psi	Head Tube Area =	p	1.0022	cm2
Cell No.	P	)max=	10.0 psi	'c)min= 5.9 psi	s'c)av= 8.0 psi	Tail Tube Area =	p	0.9984 cm2

Preliminary Length/A

Lo =	2.735
dLc=	0.206
Lc=	2.529
Lo=	6.946
Ao =	42.41
Vo =	294.55
Lc=	6.423
dVc = 3 Vo * (dLc/L	
dVc=	66.57
Vc =	227.985
Ac=	35.498

Trial No.	Stage	Temp. °C	Time Day	hour	minute	second	Pressure Head Reading Mercury (inch)	Gage (psi)	Fluid Head Reading Head (cm)/cc	Tail (cm)/cc	Flow Ratio in/out	Total Head (cm H2O) gradient	Permeability (cm/sec) Preliminary Final at 20°C Dev. from Ave
1	I	18.3	04/29/1999	15	34	0		3.80	0.65	24.15		288.19	4.25E-08
	F	19.5	04/30/1999	18	15	0		3.70	7.40	18.20		275.49	4.20E-08
		Rt= 1.032	dT =	1601.00 min				3.75	6.76 cc	5.94 cc	1.14	io =44.9	2%
2	I	19.5	04/30/1999	18	18	0		3.80	0.40	24.50		285.26	4.65E-08
	F	19.8	05/03/1999	19	12	30		3.60	18.90	7.00		249.26	4.52E-08
		Rt= 1.013	dT =	4374.50 min				3.70	18.54 cc	17.47 cc	1.06	io =44.4	9%
3	I	19.8	05/03/1999	19	16	0		3.80	0.60	24.60		299.28	4.52E-08
	F	20.0	05/04/1999	18	13	0		4.00	7.00	18.90		287.18	4.37E-08
		Rt= 1.007	dT =	1377.00 min				3.90	6.41 cc	5.69 cc	1.13	io =46.6	6%
4	I	20.0	05/04/1999	18	20	0		3.80	0.35	24.55		292.42	4.15E-08
	F	19.8	05/05/1999	11	8	0		3.80	4.45	20.65		284.42	4.01E-08
		Rt= 1.007	dT =	1008.00 min				3.80	4.11 cc	3.89 cc	1.06	io =45.5	-3%
5	I	20.0	05/05/1999	12	51	0		4.00	0.80	24.30		305.84	4.27E-08
	F	19.4	05/06/1999	18	4	0		4.00	8.45	17.15		291.04	4.14E-08
		Rt= 1.012	dT =	1753.00 min				4.00	7.67 cc	7.14 cc	1.07	io =47.6	0%
6	I	19.4	05/06/1999	18	18	0		4.00	0.50	24.55		302.86	4.12E-08
	F	19.8	05/07/1999	16	1	0		3.90	5.90	19.35		292.26	4.01E-08
		Rt= 1.014	dT =	1303.00 min				3.95	5.41 cc	5.19 cc	1.04	io =47.2	-3%

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.423	cm	εαξιαλ =
Ac =	36.989	cm2	
Vc=	237.56	cm3	εωολ =

	w (%)	γτ (pcf)	γδ (pcf)
Initial	49.40	108.8	72.8
PreTest	32.81	119.9	90.3

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials:	3-6	
ave K @ 20 °C:	**4.13E-08**	cm/sec
(io)ave =	46.73	

Tested By: BB Reviewed By:

BORING: Composite

Bentonite: SW101 3% dry

Project No. 3808E06011

Project Name: DETREX

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or				
	x	with stones or		Stones with filter paper or		top + bottom		
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination				
5) Direction of permeant :	x	Up during or		Down during permeation				
3) During saturation: Water flushed up sides of specimen to remove air:					x	No		Yes
4) During consolidation:	x	Top and bottom drainage or				Top		Bottom only
6) Permeant used :		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)
or ___DNAPL								

Stage No.:	5	sc	110.0	psi	System: p=pipette, a = annulus, b =both			
Apparatus No.	2	Ub	100.0	psi	Head Tube Area =	p	1.0022	cm2
Cell No.	P	)max=	10.0 psi	'c)min= 5.8 psi	s'c)av= 7.9 psi	Tail Tube Area =	p	0.9984 cm2

Preliminary Length/A

Lo =	2.735
dLc=	0.206
Lc=	2.529
Lo=	6.946
Ao =	42.41
Vo =	294.55
Lc=	6.423
dVc = 3 Vo * (dLc/L	
dVc=	66.57
Vc =	227.985
Ac=	35.498

Trial No.	Stage	Temp. ° C	Time Day	hour	minute	second	Pressure Head Reading Mercury (inch)	Gage (psi)	Fluid Head Reading Head (cm)/cc	Tail (cm)/cc	Flow Ratio in/out	Total Head (cm H2O) gradient	Permeability (cm/sec) Preliminary Final at 20°C Dev. from Ave
1	I	19.5	05/07/1999	17	58	0		4.00	1.00	24.10		298.38	3.71E-08
	F	21.4	05/10/1999	9	24	0		3.80	20.10	16.50		271.68	3.54E-08
		Rt= 0.994	dT =	3806.00 min				3.90	19.14 cc	7.59 cc	2.52	io =46.5	0%

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.423	cm	εαξιαλ =
Ac =	36.989	cm2	
Vc=	237.56	cm3	εϖολ =

	w (%)	γτ (pcf)	γδ (pcf)
Initial	49.40	108.8	72.8
PreTest	32.81	119.9	90.3

HYDRAULIC CONDUCTIVITY SUMMARY

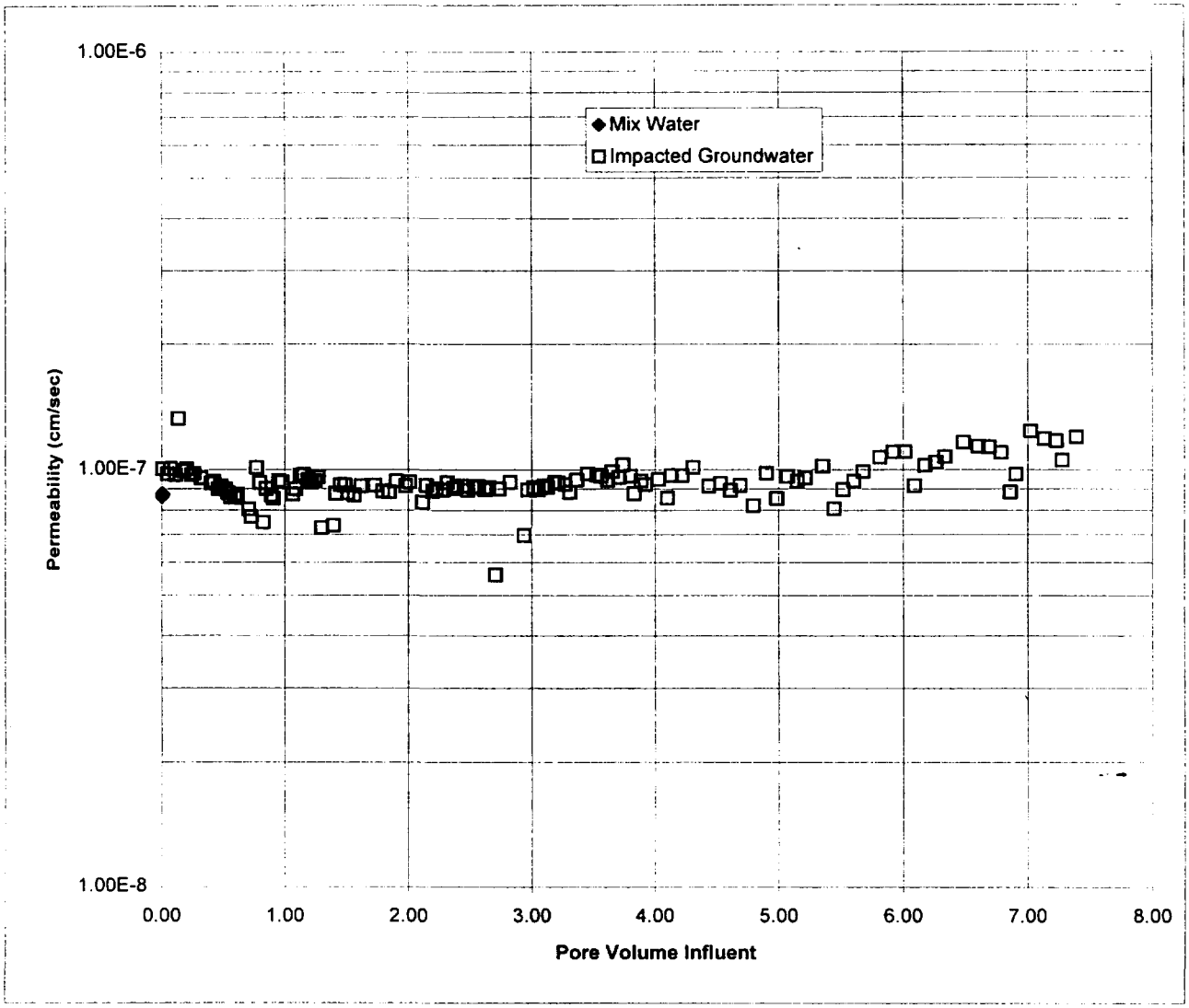
Averages for trials:	1.00	
ave K @ 20 °C:	**3.54E-08**	cm/sec
(io)ave =	46.46	

Tested By: BB Reviewed By:

BORING: Composite
Bentonite: SW101 3% dry
Project No. 3808E06011
Project Name: DETREX

Project No. 38-08E06011
Project Name: Detrex
Boring No. Composite
Sample No. Attapulgite
+3% dry

Test No.: Compsum1



PERMEABILITY TEST SUMMARY
ASTM D5084

Project No. 38-08E06011
Project Name: Detrex

Boring No. Composite
Sample No. Attapulgite
+3% dry

Test No.: P5328.xls
Volume Voids 111.8 cm^3

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
1	Tap	19.0	03/11/1999	0.2	0.2	0.0	0.2	0.2	0.0	9.37E-8
2	Tap	19.3	03/11/1999	0.2	0.4	0.0	0.2	0.4	0.0	9.09E-8
3	Tap	19.3	03/11/1999	0.2	0.6	0.0	0.2	0.6	0.0	9.00E-8
4	Tap	19.3	03/11/1999	0.2	0.8	0.0	0.2	0.8	0.0	8.99E-8
5	Tap	18.9	03/11/1999	0.3	1.1	0.0	0.3	1.1	0.0	8.86E-8
1	Mix Water	18.9	03/12/1999	0.2	0.2	0.0	0.2	0.2	0.0	8.62E-8
2	Mix Water	19.6	03/12/1999	0.2	0.4	0.0	0.2	0.4	0.0	8.75E-8
3	Mix Water	20.2	03/12/1999	0.2	0.6	0.0	0.2	0.6	0.0	8.71E-8
4	Mix Water	19.6	03/12/1999	0.2	0.8	0.0	0.2	0.8	0.0	8.70E-8
5	Mix Water	17.7	03/15/1999	0.2	1.1	0.0	0.2	1.1	0.0	8.74E-8
1	Impacted GW	22.7	03/15/1999	0.8	0.8	0.0	0.8	0.8	0.0	1.00E-7
2	Impacted GW	23.1	03/15/1999	4.6	5.4	0.0	4.4	5.2	0.2	9.76E-8
3	Impacted GW	24.7	03/16/1999	2.7	8.1	0.1	2.7	7.9	0.2	1.00E-7
4	Impacted GW	23.7	03/16/1999	4.5	12.6	0.1	4.4	12.3	0.3	9.70E-8
5	Impacted GW	23.6	03/17/1999	2.6	15.2	0.1	2.6	14.9	0.3	1.33E-7
6	Impacted GW	23.6	03/17/1999	4.6	19.8	0.2	4.5	19.4	0.4	9.91E-8
7	Impacted GW	23.7	03/18/1999	3.0	22.8	0.2	3.0	22.3	0.5	1.00E-7
8	Impacted GW	23.8	03/18/1999	4.1	26.9	0.2	4.1	26.4	0.5	9.70E-8
9	Impacted GW	23.6	03/19/1999	2.6	29.4	0.3	2.6	29.0	0.5	9.77E-8
10	Impacted GW	23.8	03/19/1999	6.3	35.8	0.3	6.2	35.2	0.5	9.53E-8
11	Impacted GW	23.8	03/20/1999	9.1	44.8	0.4	9.0	44.2	0.7	9.26E-8
12	Impacted GW	23.7	03/22/1999	2.3	47.1	0.4	2.4	46.5	0.6	9.37E-8
13	Impacted GW	23.8	03/22/1999	4.2	51.4	0.5	4.2	50.7	0.6	8.98E-8
14	Impacted GW	23.8	03/23/1999	2.4	53.8	0.5	2.4	53.1	0.7	9.13E-8
15	Impacted GW	23.7	03/23/1999	4.2	57.9	0.5	4.1	57.2	0.7	8.96E-8
16	Impacted GW	23.7	03/24/1999	2.2	60.1	0.5	2.3	59.5	0.7	8.79E-8
17	Impacted GW	23.6	03/25/1999	2.1	62.3	0.6	2.2	61.6	0.6	8.60E-8
18	Impacted GW	23.7	03/25/1999	4.1	66.4	0.6	4.1	65.7	0.7	8.57E-8
19	Impacted GW	23.8	03/26/1999	2.5	68.9	0.6	2.5	68.2	0.7	8.72E-8
20	Impacted GW	22.2	03/26/1999	10.3	79.2	0.7	10.4	78.6	0.6	8.04E-8
21	Impacted GW	23.6	03/29/1999	2.0	81.2	0.7	2.2	80.9	0.4	7.71E-8
22	Impacted GW	25.2	03/29/1999	5.0	86.2	0.8	4.8	85.7	0.6	1.01E-7
23	Impacted GW	24.7	03/30/1999	2.9	89.2	0.8	2.9	88.6	0.6	9.29E-8
24	Impacted GW	23.7	03/30/1999	3.3	92.4	0.8	3.3	91.9	0.5	7.47E-8
25	Impacted GW	22.5	03/31/1999	2.6	95.0	0.9	2.6	94.5	0.5	9.00E-8
26	Impacted GW	23.7	03/31/1999	4.2	99.2	0.9	4.0	98.5	0.8	8.68E-8
27	Impacted GW	23.8	04/01/1999	2.2	101.4	0.9	2.3	100.8	0.7	8.52E-8
28	Impacted GW	24.8	04/01/1999	4.8	106.3	1.0	4.8	105.5	0.7	9.41E-8
29	Impacted GW	24.8	04/02/1999	3.1	109.4	1.0	3.2	108.7	0.7	9.32E-8

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
30	Impacted GW	19.2	04/02/1999	9.5	118.9	1.1	9.3	118.0	0.9	8.73E-8
31	Impacted GW	24.7	04/05/1999	3.0	121.9	1.1	3.1	121.1	0.8	8.99E-8
32	Impacted GW	22.8	04/05/1999	4.2	126.0	1.1	4.0	125.1	0.9	9.69E-8
33	Impacted GW	24.8	04/06/1999	2.9	129.0	1.2	3.0	128.1	0.9	9.73E-8
34	Impacted GW	22.2	04/06/1999	4.0	132.9	1.2	3.8	131.9	1.0	9.44E-8
35	Impacted GW	22.6	04/07/1999	2.8	135.7	1.2	2.8	134.7	1.0	9.32E-8
36	Impacted GW	22.7	04/07/1999	3.6	139.3	1.2	3.4	138.0	1.3	9.39E-8
37	Impacted GW	23.7	04/08/1999	2.7	142.0	1.3	2.6	140.7	1.4	9.58E-8
38	Impacted GW	23.8	04/08/1999	3.1	145.1	1.3	3.1	143.8	1.4	7.26E-8
40	Impacted GW	23.7	04/09/1999	10.7	155.8	1.4	10.2	153.9	1.9	7.36E-8
41	Impacted GW	23.0	04/12/1999	2.3	158.1	1.4	2.3	156.2	1.8	8.76E-8
42	Impacted GW	22.7	04/12/1999	4.1	162.2	1.5	4.0	160.2	2.0	9.19E-8
43	Impacted GW	24.2	04/13/1999	4.3	166.4	1.5	4.2	164.4	2.0	9.17E-8
44	Impacted GW	23.7	04/14/1999	2.4	168.9	1.5	2.5	166.9	2.0	8.78E-8
45	Impacted GW	23.3	04/14/1999	5.9	174.8	1.6	5.9	172.8	2.0	8.68E-8
46	Impacted GW	23.6	04/15/1999	6.1	180.9	1.6	6.0	178.8	2.1	9.13E-8
47	Impacted GW	23.9	04/16/1999	12.4	193.3	1.7	12.2	191.0	2.3	9.16E-8
48	Impacted GW	23.5	04/19/1999	7.4	200.7	1.8	7.4	198.4	2.3	8.88E-8
49	Impacted GW	23.2	04/20/1999	5.9	206.6	1.8	6.0	204.4	2.2	8.83E-8
50	Impacted GW	24.3	04/21/1999	6.5	213.1	1.9	6.4	210.8	2.3	9.39E-8
51	Impacted GW	44.8	04/22/1999	8.4	221.5	2.0	8.2	219.0	2.5	9.12E-8
52	Impacted GW	44.7	04/23/1999	3.6	225.1	2.0	3.6	222.6	2.5	9.33E-8
53	Impacted GW	23.9	04/23/1999	11.7	236.8	2.1	11.7	234.4	2.4	8.35E-8
54	Impacted GW	34.1	04/26/1999	3.4	240.2	2.1	3.4	237.7	2.5	9.17E-8
55	Impacted GW	34.3	04/26/1999	6.0	246.2	2.2	6.0	243.7	2.5	8.88E-8
56	Impacted GW	34.3	04/27/1999	3.3	249.5	2.2	3.2	247.0	2.5	9.00E-8
57	Impacted GW	33.7	04/27/1999	6.0	255.4	2.3	5.9	252.9	2.5	8.94E-8
58	Impacted GW	34.2	04/28/1999	3.7	259.1	2.3	3.7	256.6	2.6	9.30E-8
59	Impacted GW	34.2	04/28/1999	5.8	265.0	2.4	5.8	262.4	2.6	9.01E-8
60	Impacted GW	34.3	04/29/1999	3.0	268.0	2.4	3.0	265.3	2.6	9.13E-8
61	Impacted GW	33.3	04/29/1999	6.3	274.3	2.5	6.3	271.6	2.6	9.12E-8
62	Impacted GW	34.3	04/30/1999	3.6	277.8	2.5	3.5	275.2	2.7	8.92E-8
63	Impacted GW	34.3	05/04/1999	5.9	283.8	2.5	5.8	281.0	2.8	9.08E-8
64	Impacted GW	34.3	05/05/1999	3.8	287.6	2.6	3.8	284.7	2.9	9.12E-8
65	Impacted GW	34.2	05/05/1999	5.6	293.2	2.6	5.6	290.3	2.9	8.95E-8
66	Impacted GW	34.3	05/06/1999	3.5	296.7	2.7	3.5	293.8	3.0	9.07E-8
67	Impacted GW	34.3	05/06/1999	5.9	302.6	2.7	5.8	299.6	3.0	5.60E-8
68	Impacted GW	34.3	05/07/1999	3.4	306.0	2.7	3.4	302.9	3.1	9.00E-8
69	Impacted GW	34.3	05/07/1999	9.9	315.9	2.8	9.8	312.7	3.2	9.32E-8
70	Impacted GW	35.8	05/08/1999	12.7	328.6	2.9	12.7	325.4	3.3	6.97E-8
71	Impacted GW	34.2	05/10/1999	3.1	331.7	3.0	3.1	328.4	3.3	8.95E-8
72	Impacted GW	32.1	05/10/1999	5.8	337.6	3.0	5.8	334.2	3.3	9.08E-8
73	Impacted GW	34.3	05/11/1999	4.0	341.6	3.1	4.0	338.2	3.4	8.96E-8
74	Impacted GW	34.4	05/11/1999	5.5	347.0	3.1	5.5	343.7	3.4	9.15E-8
75	Impacted GW	34.2	05/12/1999	3.3	350.3	3.1	3.2	346.9	3.4	9.07E-8
76	Impacted GW	35.4	05/12/1999	6.5	356.8	3.2	6.5	353.4	3.4	9.33E-8
77	Impacted GW	34.2	05/13/1999	3.1	359.9	3.2	3.1	356.4	3.4	9.29E-8
78	Impacted GW	34.2	05/13/1999	6.2	366.1	3.3	5.9	362.4	3.8	9.22E-8

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
79	Impacted GW	34.2	05/14/1999	4.3	370.5	3.3	4.2	366.5	3.9	8.84E-8
80	Impacted GW	34.5	05/14/1999	6.3	376.7	3.4	6.1	372.6	4.1	9.44E-8
81	Impacted GW	35.2	05/15/1999	10.0	386.7	3.5	9.7	382.3	4.4	9.77E-8
82	Impacted GW	33.9	05/16/1999	8.2	394.9	3.5	8.1	390.5	4.5	9.70E-8
83	Impacted GW	35.3	05/17/1999	3.7	398.7	3.6	3.7	394.1	4.5	9.63E-8
84	Impacted GW	34.3	05/17/1999	6.2	404.8	3.6	6.1	400.3	4.6	9.43E-8
85	Impacted GW	35.2	05/18/1999	3.9	408.7	3.7	3.8	404.1	4.7	9.88E-8
86	Impacted GW	34.2	05/18/1999	6.4	415.1	3.7	6.3	410.4	4.7	9.56E-8
87	Impacted GW	34.3	05/19/1999	3.5	418.6	3.7	3.5	413.9	4.7	1.03E-7
88	Impacted GW	34.3	05/19/1999	6.6	425.2	3.8	6.5	420.4	4.7	9.64E-8
89	Impacted GW	34.2	05/20/1999	3.3	428.5	3.8	3.3	423.7	4.8	8.77E-8
90	Impacted GW	34.3	05/20/1999	6.2	434.7	3.9	6.0	429.8	5.0	9.41E-8
91	Impacted GW	32.8	05/21/1999	3.7	438.4	3.9	3.6	433.4	5.0	9.21E-8
92	Impacted GW	22.9	05/21/1999	12.0	450.4	4.0	11.8	445.2	5.2	9.47E-8
93	Impacted GW	34.3	05/24/1999	8.0	458.4	4.1	8.0	453.2	5.2	8.56E-8
94	Impacted GW	33.2	05/25/1999	3.6	462.0	4.1	3.6	456.8	5.2	9.68E-8
95	Impacted GW	36.4	05/25/1999	9.6	471.6	4.2	9.5	466.3	5.3	9.66E-8
96	Impacted GW	36.9	05/26/1999	10.1	481.7	4.3	10.0	476.3	5.3	1.01E-7
97	Impacted GW	21.8	05/28/1999	14.4	496.1	4.4	11.7	488.0	8.1	9.13E-8
98	Impacted GW	32.1	06/01/1999	10.4	506.5	4.5	9.9	497.9	8.6	9.27E-8
99	Impacted GW	34.2	06/02/1999	9.1	515.6	4.6	8.8	506.7	8.9	8.92E-8
100	Impacted GW	34.2	06/03/1999	8.8	524.4	4.7	8.5	515.2	9.2	9.16E-8
101	Impacted GW	23.8	06/04/1999	11.7	536.1	4.8	11.2	526.4	9.7	8.21E-8
102	Impacted GW	34.2	06/07/1999	12.0	548.2	4.9	11.8	538.2	10.0	9.78E-8
103	Impacted GW	34.2	06/08/1999	9.0	557.2	5.0	8.8	547.0	10.3	8.52E-8
104	Impacted GW	35.3	06/09/1999	9.6	566.8	5.1	9.4	556.3	10.4	9.62E-8
105	Impacted GW	34.2	06/10/1999	8.8	575.6	5.1	8.7	565.0	10.6	9.37E-8
106	Impacted GW	34.3	06/11/1999	7.1	582.7	5.2	7.0	572.0	10.6	9.53E-8
107	Impacted GW	34.2	06/12/1999	15.6	598.2	5.4	14.5	586.5	11.7	1.02E-7
108	Impacted GW	34.2	06/14/1999	10.4	608.7	5.4	10.2	596.7	11.9	8.07E-8
109	Impacted GW	34.5	06/15/1999	8.2	616.8	5.5	7.8	604.6	12.2	8.95E-8
110	Impacted GW	34.2	06/16/1999	9.5	626.3	5.6	9.2	613.8	12.5	9.38E-8
111	Impacted GW	34.3	06/17/1999	8.4	634.7	5.7	8.3	622.1	12.6	9.89E-8
112	Impacted GW	34.2	06/18/1999	15.3	650.0	5.8	15.4	637.5	12.6	1.07E-7
113	Impacted GW	34.2	06/20/1999	12.1	662.1	5.9	12.0	649.4	12.7	1.10E-7
114	Impacted GW	34.2	06/21/1999	10.2	672.3	6.0	10.2	659.6	12.7	1.10E-7
115	Impacted GW	33.9	06/22/1999	8.7	681.0	6.1	9.3	668.9	12.1	9.14E-8
116	Impacted GW	34.3	06/23/1999	9.5	690.5	6.2	9.3	678.2	12.2	1.02E-7
117	Impacted GW	34.2	06/24/1999	9.6	700.1	6.3	9.5	687.8	12.3	1.04E-7
118	Impacted GW	34.2	06/25/1999	8.2	708.3	6.3	8.1	695.9	12.5	1.07E-7
119	Impacted GW	34.3	06/26/1999	16.3	724.6	6.5	16.3	712.2	12.5	1.16E-7
120	Impacted GW	34.1	06/28/1999	13.2	737.8	6.6	13.1	725.3	12.5	1.14E-7
121	Impacted GW	34.1	06/29/1999	9.8	747.6	6.7	9.7	735.0	12.6	1.13E-7
122	Impacted GW	34.1	06/30/1999	10.7	758.3	6.8	10.6	745.6	12.7	1.10E-7
123	Impacted GW	34.2	07/01/1999	8.5	766.8	6.9	8.5	754.1	12.7	8.84E-8
124	Impacted GW	23.8	07/02/1999	5.1	772.0	6.9	4.9	759.0	13.0	9.74E-8
130	Impacted GW	34.4	07/06/1999	13.3	785.3	7.0	13.0	771.9	13.3	1.24E-7
131	Impacted GW	34.3	07/07/1999	12.2	797.5	7.1	12.0	784.0	13.6	1.19E-7

				Influent			Effluent		Sum	
Stage	Permeant Type	Gradient	Date	Qstage (cc)	Qtotal (cc)	Pore Volumes Influent	Qstage (cc)	Qtotal (cc)	Water In (cc)	Hydraulic Conductivity (cm/sec)
132	Impacted GW	34.3	07/08/1999	10.6	808.1	7.2	10.5	794.5	13.6	1.17E-7
133	Impacted GW	23.8	07/09/1999	5.4	813.5	7.3	5.3	799.8	13.7	1.05E-7
134	Impacted GW	23.7	07/10/1999	12.8	826.3	7.4	12.6	812.4	13.9	1.20E-7

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 SAMPLE: Composite Test No.: P5328

Project Name: Detrex ADDITIVE: Attapulgite PERCENT: +3% dry

Specimen - Apparatus set-up - Test Information Cell No. H-2 Appara 7 Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.741	in	Lo=	6.962	cm
dLc=	0.102	in	Ao =	42.25	cm2
Lc=	2.639	in	Vo =	294.14	cm3
			Lc=	6.703	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	32.84	cm3
			Vc =	261.30	cm3
Sc =	0.172	cm-1	Ac=	38.984	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or			top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used		Tap		Distilled			
or Mix		Demineralized		0.005 N calcium sulfate (CaSO4)			

Equations Used

Kt = - 0.0000757 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.3155

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.703	cm	ξιαλ =	3.7%	
Ac =	38.058	cm2			
Vc=	255.09	cm3	εϖολ =	13.3%	
Sc =	0.176	cm-1	Sc = Lc / Ac , final		

	w (%)	γτ (pcf)	γδ (pcf)	S (%)
Initial	37.87	116.6	84.6	100.0
PreTest	28.07	124.9	97.5	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **8.69E-08** cm/sec

(io)ave = 19.6

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	min	sec	Initial sc psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.6	03/12/1999	09	27	00	105.0	100.0	57.50	47.45	0.96	8.73E-08
final	21.7	03/12/1999	10	32	00			54.80	48.34		8.62E-08
1	RT = 0.964	dT =		65.00 min		s'c =	0.7 ksf	0.203	0.212	io= 18.9	-1%
initial	21.7	03/12/1999	10	35	00	105.0	100.0	57.80	47.36	1.00	8.87E-08
final	21.7	03/12/1999	11	30	00			55.32	48.14		8.75E-08
2	RT = 0.963	dT =		55.00 min		s'c =	0.7 ksf	0.186	0.186	io= 19.6	1%
initial	21.7	03/12/1999	11	33	00	105.0	100.0	58.06	47.28	0.98	8.81E-08
final	21.5	03/12/1999	12	45	00			54.90	48.30		8.71E-08
3	RT = 0.965	dT =		72.00 min		s'c =	0.7 ksf	0.237	0.243	io= 20.2	0%
initial	21.5	03/12/1999	12	49	00	105.0	100.0	57.80	47.36	0.98	8.77E-08
final	21.5	03/12/1999	13	49	00			55.16	48.21		8.70E-08
4	RT = 0.968	dT =		60.00 min		s'c =	0.7 ksf	0.198	0.202	io= 19.6	0%
initial	21.6	03/15/1999	09	27	00	105.0	100.0	57.05	47.60	0.99	8.84E-08
final	21.6	03/15/1999	10	52	00			53.90	48.60		8.74E-08
5	RT = 0.965	dT =		85.00 min		s'c =	0.7 ksf	0.237	0.238	io= 17.7	1%
								0.000	0.000		

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No. H-2

Stage No.: 4 sc 105.0 psi — System: p=pipette a = annulus b =both

Apparatus No. 7 Ub 100.0 psi — Head Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

(s'c)max= 5.0 psi (s'c)min= 2.8 psi 'c)av= 3.9 psi — Tail Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

Preliminary Length/A

Lo = 2.741
dLc= 0.102
Lc= 2.639
Lo= 6.962
Ao = 42.25
Vo = 294.14
Lc= 6.703
dVc = 3 Vo * (dLc/L
dVc= 32.84
Vc = 261.299
Ac= 38.984

Trial No.	Stage	Temp. °C	Time Day	hour	minute	second	Pressure Head Reading Mercury (inch)	Gage (psi)	Fluid Head Reading Head (cm)/cc	Tail (cm)/cc	Burette Flow Ratio in/out	Total Head (cm H2O) gradient	Permeability (cm/sec) Preliminary Final at 20°C Dev. from Ave
1	I	21.5	03/15/1999	14	10	0		1.00	95.30	9.90	p	152.45	1.01E-07
	F	21.5	03/15/1999	16	41	0		0.90	91.90	13.30	p	145.65	1.00E-07
		Rt= 0.968	dT =	151.00 min				0.95	0.80 cc	0.80 cc	1.00	io =22.7	-6%
2	I	21.5	03/15/1999	16	45	0		1.00	98.30	10.40	p	154.95	9.85E-08
	F	21.5	03/16/1999	9	6	0		0.90	78.50	29.40	p	116.15	9.76E-08
		Rt= 0.968	dT =	981.00 min				0.95	4.63 cc	4.44 cc	1.04	io =23.1	-9%
3	I	21.5	03/16/1999	9	10	0		1.00	98.70	10.90	p	165.44	1.01E-07
	F	21.5	03/16/1999	17	23	0		1.20	87.20	22.30	p	142.54	1.00E-07
		Rt= 0.968	dT =	493.00 min				1.10	2.69 cc	2.67 cc	1.01	io =24.7	-6%
4	I	21.5	03/16/1999	17	28	0		1.00	98.95	10.70	p	158.83	9.82E-08
	F	21.8	03/17/1999	9	8	0		1.00	79.60	29.60	p	120.58	9.70E-08
		Rt= 0.964	dT =	940.00 min				1.00	4.53 cc	4.42 cc	1.02	io =23.7	-9%
5	I	21.8	03/17/1999	9	14	0		1.00	98.45	10.80	p	158.23	1.35E-07
	F	22.1	03/17/1999	15	26	0		1.00	87.40	21.80	p	136.18	1.33E-07
		Rt= 0.957	dT =	372.00 min				1.00	2.58 cc	2.57 cc	1.00	io =23.6	24%
6	I	22.1	03/17/1999	17	36	0		1.00	98.45	11.15	p	157.88	1.01E-07
	F	21.7	03/18/1999	9	6	0		1.00	78.90	30.20	p	119.28	9.91E-08
		Rt= 0.958	dT =	930.00 min				1.00	4.57 cc	4.46 cc	1.03	io =23.6	-7%
7	I	21.7	03/18/1999	9	9	0		1.00	98.75	10.25	p	159.08	1.01E-07
	F	21.0	03/18/1999	18	46	0		1.00	86.05	22.90	p	133.73	1.00E-07
		Rt= 0.971	dT =	577.00 min				1.00	2.97 cc	2.96 cc	1.00	io =23.7	-6%
8	I	21.0	03/18/1999	18	48	0		1.00	98.70	9.80	p	159.48	9.73E-08
	F	21.6	03/19/1999	9	1	0		1.00	81.15	27.25	p	124.48	9.70E-08
		Rt= 0.973	dT =	853.00 min				1.00	4.10 cc	4.08 cc	1.01	io =23.8	-9%
9	I	21.6	03/19/1999	9	4	0		1.00	98.70	10.95	p	158.33	9.84E-08
	F	21.3	03/19/1999	17	32	0		1.00	87.70	21.90	p	136.38	9.77E-08
		Rt= 0.969	dT =	508.00 min				1.00	2.57 cc	2.56 cc	1.00	io =23.6	-9%
10	I	21.3	03/19/1999	17	38	0		1.00	98.85	10.20	p	159.23	9.56E-08
	F	21.2	03/20/1999	17	39	0		1.00	71.90	36.90	p	105.58	9.53E-08
		Rt= 0.974	dT =	1441.00 min				1.00	6.30 cc	6.25 cc	1.01	io =23.8	-11%
11	I	21.2	03/20/1999	17	42	0		1.00	98.85	10.10	p	159.33	9.34E-08
	F	21.8	03/22/1999	9	12	0		1.00	60.10	48.40	p	82.28	9.26E-08
		Rt= 0.968	dT =	2370.00 min				1.00	9.06 cc	8.96 cc	1.01	io =23.8	-13%
12	I	21.8	03/22/1999	9	17	0		1.00	98.80	10.75	p	158.63	9.48E-08
	F	21.4	03/22/1999	17	11	0		1.00	88.95	20.80	p	138.73	9.37E-08
		Rt= 0.965	dT =	474.00 min				1.00	2.30 cc	2.35 cc	0.98	io =23.7	-12%
13	I	21.4	03/22/1999	17	15	0		1.00	98.75	9.90	p	159.43	9.08E-08
	F	21.8	03/23/1999	9	6	0		1.00	80.60	27.95	p	123.23	8.98E-08
		Rt= 0.965	dT =	951.00 min				1.00	4.25 cc	4.22 cc	1.01	io =23.8	-16%
14	I	21.8	03/23/1999	9	10	0		1.00	98.90	10.05	p	159.43	9.20E-08

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.703 cm εαξιαλ =
Ac = 38.055 cm2
Vc= 255.07 cm3 εωολ =

	w (%)	γt (pcf)	γδ (pcf)
Initial	37.87	116.6	84.6
PreTest	28.06	124.9	97.5

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 2-5
ave K @ 20 °C: 1.07E-07 cm/sec
(io)ave = 23.78

Tested By: Reviewed By:

SAMPLE: Composite
ADDITIVE: Attapulgite
Project No. 38-08E06011
Project Name: Detrex

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-2										
Stage No.:	4	sc	105.0	psi	System: p=pipette a = annulus b =both						
Apparatus No.	7	Ub	100.0	psi	Head Tube Area =	0.2339	0.0000	0.0000	cm2	cm2	
(s'c)max= 5.0 psi	(s'c)min= 2.8 psi	'c)av= 3.9 psi			Tail Tube Area =	0.2339	0.0000	0.0000	cm2	cm2	

Preliminary Length/A

Lo =	2.741
dLc=	0.102
Lc=	2.639
Lo=	6.962
Ao =	42.25
Vo =	294.14
Lc=	6.703
dVc = 3 Vo * (dLc/L	
dVc=	32.84
Vc =	261.299
Ac=	38.984

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
	F	21.1	03/23/1999	17	30	0		1.00	88.60	20.20	p	138.98	9.13E-08
		Rt= 0.969	dT =	500.00 min				1.00	2.41 cc	2.37 cc	1.01	io =23.8	-15%
15	I	21.1	03/23/1999	17	33	0		1.00	98.95	10.35	p	159.18	9.00E-08
	F	21.5	03/24/1999	9	10	0		1.00	81.15	27.95	p	123.78	8.96E-08
		Rt= 0.973	dT =	937.00 min				1.00	4.16 cc	4.12 cc	1.01	io =23.7	-16%
16	I	21.5	03/24/1999	9	12	0		1.00	98.90	10.70	p	158.78	8.95E-08
	F	22.2	03/24/1999	17	12	0		1.00	89.45	20.35	p	139.68	8.79E-08
		Rt= 0.959	dT =	480.00 min				1.00	2.21 cc	2.26 cc	0.98	io =23.7	-18%
17	I	21.7	03/25/1999	9	8	0		1.00	98.85	11.25	p	158.18	8.67E-08
	F	21.3	03/25/1999	17	3	0		1.00	89.75	20.45	p	139.88	8.60E-08
		Rt= 0.968	dT =	475.00 min				1.00	2.13 cc	2.15 cc	0.99	io =23.6	-20%
18	I	21.3	03/25/1999	17	7	0		1.00	98.75	10.35	p	158.98	8.63E-08
	F	21.6	03/26/1999	9	20	0		1.00	81.05	27.90	p	123.73	8.57E-08
		Rt= 0.969	dT =	973.00 min				1.00	4.14 cc	4.10 cc	1.01	io =23.7	-20%
19	I	21.6	03/26/1999	9	23	0		1.00	99.00	10.20	p	159.38	8.75E-08
	F	21.0	03/26/1999	18	27	0		1.00	88.40	20.70	p	138.28	8.72E-08
		Rt= 0.973	dT =	544.00 min				1.00	2.48 cc	2.46 cc	1.01	io =23.8	-18%
20	I	21.0	03/26/1999	18	29	0		1.00	99.00	10.20	p	148.80	8.08E-08
	F	21.7	03/29/1999	9	10	0		0.70	54.90	54.80	p	60.10	8.04E-08
		Rt= 0.971	dT =	3761.00 min				0.85	10.31 cc	10.43 cc	0.99	io =22.2	-25%
21	I	21.7	03/29/1999	9	16	0		1.00	98.90	11.35	p	158.13	8.03E-08
	F	23.8	03/29/1999	17	48	0		1.00	90.20	20.90	p	139.88	7.71E-08
		Rt= 0.937	dT =	512.00 min				1.00	2.03 cc	2.23 cc	0.91	io =23.6	-28%
22	I	23.8	03/29/1999	17	57	0		1.00	98.95	11.15	p	168.97	1.05E-07
	F	21.7	03/30/1999	9	5	0		1.30	77.60	31.70	p	127.07	1.01E-07
		Rt= 0.937	dT =	908.00 min				1.15	4.99 cc	4.81 cc	1.04	io =25.2	-6%
23	I	21.7	03/30/1999	9	12	0		1.00	98.65	10.65	p	165.64	9.42E-08
	F	21.7	03/30/1999	18	53	0		1.20	86.20	23.15	p	140.69	9.29E-08
		Rt= 0.963	dT =	581.00 min				1.10	2.91 cc	2.92 cc	1.00	io =24.7	-13%
24	I	21.7	03/30/1999	18	57	0		1.00	98.90	10.70	p	158.78	7.70E-08
	F	23.0	03/31/1999	9	6	0		1.00	84.85	24.80	p	130.63	7.47E-08
		Rt= 0.947	dT =	849.00 min				1.00	3.29 cc	3.30 cc	1.00	io =23.7	-30%
25	I	23.0	03/31/1999	9	13	0		1.00	98.60	11.10	p	151.03	9.75E-08
	F	25.5	03/31/1999	18	18	0		0.80	87.55	22.20	p	128.88	9.00E-08
		Rt= 0.900	dT =	545.00 min				0.90	2.58 cc	2.60 cc	1.00	io =22.5	-16%
26	I	25.5	03/31/1999	18	26	0		1.00	98.80	10.20	p	159.18	9.25E-08
	F	21.7	04/01/1999	9	26	0		1.00	80.80	27.20	p	124.18	8.68E-08
		Rt= 0.916	dT =	900.00 min				1.00	4.21 cc	3.98 cc	1.06	io =23.7	-19%
27	I	21.7	04/01/1999	9	34	0		1.00	99.00	10.30	p	159.28	9.02E-08
	F	25.0	04/01/1999	17	34	0		1.00	89.60	20.20	p	139.98	8.52E-08
		Rt= 0.922	dT =	480.00 min				1.00	2.20 cc	2.32 cc	0.95	io =23.8	-20%
28	I	25.0	04/01/1999	17	41	0		1.00	98.70	9.85	p	166.49	1.03E-07
	F	24.0	04/02/1999	9	5	0		1.20	78.00	30.20	p	125.44	9.41E-08
		Rt= 0.894	dT =	924.00 min				1.10	4.84 cc	4.76 cc	1.02	io =24.8	-12%

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.703 cm εαξιαλ =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
5) Direction of permeant :	x	Up during or		Down during permeation		
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or 0.005 N calcium sulfate (CaSO4)

Cell No. H-2

Stage No. 4 sc 105.0 psi System: p=pipette a = annulus b =both

Apparatus No. 7 Ub 100.0 psi Head Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

(s'c)max= 5.0 psi (s'c)min= 2.8 psi 'c)av= 3.9 psi Tail Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

Preliminary Length/A

Lo = 2.741
dLc= 0.102
Lc= 2.639
Lo= 6.962
Ao = 42.25
Vo = 294.14
Lc= 6.703
dVc = 3 Vo * (dLc/L
dVc= 32.84
Vc = 261.299
Ac= 38.984

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
29	I	24.0	04/02/1999	9	9	0		1.00	98.90	10.55	p	165.99	9.89E-08
	F	22.9	04/02/1999	19	7	0		1.20	85.55	24.05	p	139.14	9.32E-08
		Rt= 0.920	dT =	598.00 min				1.10	3.12 cc	3.16 cc	0.99	io =24.8	-13%
30	I	22.9	04/02/1999	19	15	0		1.00	99.10	9.30	p	128.62	8.97E-08
	F	21.6	04/05/1999	8	12	0		0.10	58.55	49.05	p	48.32	8.73E-08
		Rt= 0.949	dT =	3657.00 min				0.55	9.48 cc	9.30 cc	1.02	io =19.2	-18%
31	I	21.6	04/05/1999	8	28	0		1.00	99.20	11.25	p	165.59	9.40E-08
	F	24.2	04/05/1999	18	41	0		1.20	86.35	24.55	p	139.44	8.99E-08
		Rt= 0.933	dT =	613.00 min				1.10	3.01 cc	3.11 cc	0.97	io =24.7	-16%
32	I	24.2	04/05/1999	18	47	0		1.00	99.20	10.10	p	152.63	1.01E-07
	F	21.7	04/06/1999	9	9	0		0.80	81.40	27.35	p	117.58	9.69E-08
		Rt= 0.932	dT =	862.00 min				0.90	4.16 cc	4.03 cc	1.03	io =22.8	-9%
33	I	21.7	04/06/1999	9	14	0		1.00	98.80	10.35	p	166.09	9.88E-08
	F	21.8	04/06/1999	18	31	0		1.20	86.35	23.05	p	140.94	9.73E-08
		Rt= 0.962	dT =	557.00 min				1.10	2.91 cc	2.97 cc	0.98	io =24.8	-9%
34	I	21.8	04/06/1999	18	37	0		1.00	98.85	9.95	p	148.90	9.70E-08
	F	22.6	04/07/1999	9	9	0		0.70	81.90	26.20	p	115.70	9.44E-08
		Rt= 0.951	dT =	872.00 min				0.85	3.96 cc	3.80 cc	1.04	io =22.2	-12%
35	I	22.6	04/07/1999	9	12	0		1.00	98.90	11.00	p	151.43	9.47E-08
	F	21.0	04/07/1999	19	20	0		0.80	86.90	22.90	p	127.53	9.32E-08
		Rt= 0.960	dT =	608.00 min				0.90	2.81 cc	2.78 cc	1.01	io =22.6	-13%
36	I	21.0	04/07/1999	19	23	0		1.00	98.90	10.00	p	152.43	9.47E-08
	F	22.0	04/08/1999	8	13	0		0.80	83.45	24.35	p	122.63	9.39E-08
		Rt= 0.968	dT =	770.00 min				0.90	3.61 cc	3.36 cc	1.08	io =22.7	-12%
37	I	22.0	04/08/1999	9	17	0		1.00	98.90	10.75	p	158.73	9.64E-08
	F	20.8	04/08/1999	18	11	0		1.00	87.45	21.90	p	136.13	9.58E-08
		Rt= 0.970	dT =	534.00 min				1.00	2.68 cc	2.61 cc	1.03	io =23.7	-10%
38	I	20.8	04/08/1999	18	16	0		1.00	99.00	10.00	p	159.58	7.27E-08
	F	21.7	04/09/1999	8	16	0		1.00	85.70	23.30	p	132.98	7.26E-08
		Rt= 0.974	dT =	840.00 min				1.00	3.11 cc	3.11 cc	1.00	io =23.8	-32%
40	I	21.8	04/09/1999	19	58	0		1.00	98.60	10.00	p	159.18	7.42E-08
	F	21.2	04/12/1999	9	36	0		1.00	53.00	53.40	p	70.18	7.36E-08
		Rt= 0.968	dT =	3698.00 min				1.00	10.67 cc	10.15 cc	1.05	io =23.7	-31%
41	I	21.3	04/12/1999	9	48	0		1.00	98.90	11.55	p	154.40	8.97E-08
	F	22.9	04/12/1999	18	15	0		0.90	89.20	21.45	p	134.80	8.76E-08
		Rt= 0.953	dT =	507.00 min				0.95	2.27 cc	2.32 cc	0.98	io =23.0	-18%
42	I	22.9	04/12/1999	18	18	0		1.00	99.20	10.90	p	151.83	9.45E-08
	F	21.6	04/13/1999	9	29	0		0.80	81.75	27.85	p	117.43	9.19E-08
		Rt= 0.949	dT =	911.00 min				0.90	4.08 cc	3.96 cc	1.03	io =22.7	-14%
43	I	23.0	04/13/1999	18	15	0		1.00	99.20	11.30	p	162.01	9.45E-08
	F	21.7	04/14/1999	9	9	0		1.10	81.00	29.20	p	125.91	9.17E-08
		Rt= 0.947	dT =	894.00 min				1.05	4.26 cc	4.19 cc	1.02	io =24.2	-14%
44	I	21.7	04/14/1999	9	17	0		1.00	99.00	10.70	p	158.88	9.06E-08
	F	23.1	04/14/1999	18	4	0		1.00	88.55	21.35	p	137.78	8.78E-08

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.703 cm εαξιαλ =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-2									
Stage No.:	4	sc	105.0	psi	System: p=pipette a = annulus b =both					
Apparatus No.	7	Ub	100.0	psi	Head Tube Area =	0.2339	0.0000	0.0000	cm2	cm2
(s'c)max= 5.0 psi	(s'c)min= 2.8 psi	'c)av= 3.9 psi			Tail Tube Area =	0.2339	0.0000	0.0000	cm2	cm2

Preliminary Length/A

Lo =	2.741
dLc=	0.102
Lc=	2.639
Lo=	6.962
Ao =	42.25
Vo =	294.14
Lc=	6.703
dVc = 3 Vo * (dLc/L	
dVc=	32.84
Vc =	261.299
Ac=	38.984

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
	F	21.8	04/29/1999	9	9	0		2.00	73.95	35.30	p	179.82	9.01E-08
		Rt= 0.969	dT =	900.00 min				2.00	5.81 cc	5.80 cc	1.00	io =34.2	-16%
60	I	21.8	04/29/1999	9	14	0		2.00	99.00	10.50	p	229.67	9.21E-08
	F	21.2	04/29/1999	16	25	0		2.00	86.15	23.30	p	204.02	9.13E-08
		Rt= 0.968	dT =	431.00 min				2.00	3.01 cc	2.99 cc	1.00	io =34.3	-15%
61	I	21.2	04/29/1999	16	30	0		2.00	99.00	9.75	p	223.36	9.19E-08
	F	21.7	04/30/1999	9	15	0		1.80	72.05	36.60	p	169.56	9.12E-08
		Rt= 0.969	dT =	1005.00 min				1.90	6.30 cc	6.28 cc	1.00	io =33.3	-15%
62	I	21.7	04/30/1999	9	22	0		2.00	99.05	10.20	p	230.02	8.96E-08
	F	21.0	04/30/1999	18	11	0		2.00	83.80	25.30	p	199.67	8.92E-08
		Rt= 0.971	dT =	529.00 min				2.00	3.57 cc	3.53 cc	1.01	io =34.3	-17%
63	I	21.0	05/04/1999	18	9	0		2.00	98.80	9.75	p	230.22	9.10E-08
	F	21.5	05/05/1999	9	14	0		2.00	73.50	34.60	p	180.07	9.08E-08
		Rt= 0.974	dT =	905.00 min				2.00	5.92 cc	5.81 cc	1.02	io =34.3	-15%
64	I	21.5	05/05/1999	9	21	0		2.00	98.90	9.95	p	230.12	9.16E-08
	F	21.2	05/05/1999	18	37	0		2.00	82.50	26.00	p	197.67	9.12E-08
		Rt= 0.971	dT =	556.00 min				2.00	3.84 cc	3.75 cc	1.02	io =34.3	-15%
65	I	21.2	05/05/1999	18	42	0		2.00	98.90	10.50	p	229.57	8.99E-08
	F	21.5	05/06/1999	9	12	0		2.00	74.85	34.25	p	181.77	8.95E-08
		Rt= 0.971	dT =	870.00 min				2.00	5.63 cc	5.56 cc	1.01	io =34.2	-16%
66	I	21.5	05/06/1999	9	23	0		2.00	98.90	10.15	p	229.92	9.08E-08
	F	20.9	05/06/1999	17	58	0		2.00	83.80	25.00	p	199.97	9.07E-08
		Rt= 0.975	dT =	515.00 min				2.00	3.53 cc	3.47 cc	1.02	io =34.3	-15%
67	I	20.9	05/06/1999	18	1	0		2.00	99.00	10.10	p	230.07	5.61E-08
	F	21.5	05/07/1999	18	27	0		2.00	73.90	35.05	p	180.02	5.60E-08
		Rt= 0.975	dT =	1466.00 min				2.00	5.87 cc	5.84 cc	1.01	io =34.3	-48%
68	I	21.5	05/07/1999	9	31	0		2.00	99.15	10.30	p	230.02	9.02E-08
	F	21.0	05/07/1999	17	49	0		2.00	84.65	24.65	p	201.17	9.00E-08
		Rt= 0.974	dT =	498.00 min				2.00	3.39 cc	3.36 cc	1.01	io =34.3	-16%
69	I	21.0	05/07/1999	17	52	0		2.00	99.05	10.15	p	230.07	9.33E-08
	F	21.4	05/08/1999	21	4	0		2.00	56.80	51.90	p	146.07	9.32E-08
		Rt= 0.975	dT =	1632.00 min				2.00	9.88 cc	9.77 cc	1.01	io =34.3	-13%
70	I	21.4	05/08/1999	9	13	0		2.00	99.10	10.70	p	240.16	6.99E-08
	F	21.2	05/10/1999	9	17	0		2.30	44.60	64.80	p	131.56	6.97E-08
		Rt= 0.973	dT =	2884.00 min				2.15	12.75 cc	12.65 cc	1.01	io =35.8	-35%
71	I	21.2	05/10/1999	9	21	0		2.00	99.15	11.10	p	229.22	8.92E-08
	F	20.8	05/10/1999	16	59	0		2.00	85.95	24.20	p	202.92	8.95E-08
		Rt= 0.980	dT =	458.00 min				2.00	3.09 cc	3.06 cc	1.01	io =34.2	-16%
72	I	20.8	05/10/1999	17	5	0		2.00	98.90	10.50	p	215.45	9.07E-08
	F	21.5	05/11/1999	9	17	0		1.60	73.90	35.35	p	165.60	9.08E-08
		Rt= 0.976	dT =	972.00 min				1.80	5.85 cc	5.81 cc	1.01	io =32.1	-15%
73	I	21.5	05/11/1999	9	23	0		2.00	99.00	10.15	p	230.02	8.98E-08
	F	21.0	05/11/1999	19	21	0		2.00	81.90	27.10	p	195.97	8.96E-08
		Rt= 0.974	dT =	598.00 min				2.00	4.00 cc	3.96 cc	1.01	io =34.3	-16%

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.703 cm εαξιαλ =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air					x	No	Yes
4) During consolidation:	x	Top and bottom drainage or				Top	Bottom only
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.: H-2

Stage No.: 4 sc 105.0 psi System: p=pipette a = annulus b =both

Apparatus No.: 7 Ub 100.0 psi Head Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

(s'c)max= 5.0 psi (s'c)min= 2.8 psi 'c)av= 3.9 psi Tail Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

Preliminary Length/A

Lo = 2.741
dLc= 0.102
Lc= 2.639
Lo= 6.962
Ao = 42.25
Vo = 294.14
Lc= 6.703
dVc = 3 Vo * (dLc/L
dVc= 32.84
Vc = 261.299
Ac= 38.984

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary	Permeability (cm/sec) Final at 20°C
74	I	21.0	05/11/1999	19	27	0		2.00	98.90	9.50	p	230.57		9.19E-08
	F	21.7	05/12/1999	9	13	0		2.00	75.50	32.85	p	183.82		9.15E-08
		Rt= 0.971	dT =	826.00 min				2.00	5.47 cc	5.46 cc	1.00	io =34.4		-14%
75	I	21.7	05/12/1999	9	22	0		2.00	98.95	11.05	p	229.07		9.11E-08
	F	21.0	05/12/1999	17	17	0		2.00	85.00	24.85	p	201.32		9.07E-08
		Rt= 0.971	dT =	475.00 min				2.00	3.26 cc	3.23 cc	1.01	io =34.2		-15%
76	I	21.0	05/12/1999	17	20	0		2.00	99.05	10.05	p	237.23		9.31E-08
	F	21.2	05/13/1999	9	17	0		2.20	71.30	37.70	p	181.83		9.33E-08
		Rt= 0.978	dT =	957.00 min				2.10	6.49 cc	6.47 cc	1.00	io =35.4		-13%
77	I	21.2	05/13/1999	9	25	0		2.00	98.85	10.85	p	229.17		9.28E-08
	F	21.1	05/13/1999	16	45	0		2.00	85.70	24.00	p	202.87		9.29E-08
		Rt= 0.976	dT =	440.00 min				2.00	3.08 cc	3.08 cc	1.00	io =34.2		-13%
78	I	21.1	05/13/1999	17	34	0		2.00	98.60	10.50	p	229.27		9.26E-08
	F	21.6	05/14/1999	9	6	0		2.00	71.90	35.85	p	177.22		9.22E-08
		Rt= 0.971	dT =	932.00 min				2.00	6.25 cc	5.93 cc	1.05	io =34.2		-14%
79	I	21.6	05/14/1999	9	9	0		2.00	99.00	10.80	p	229.37		8.88E-08
	F	21.1	05/14/1999	19	58	0		2.00	80.50	28.55	p	193.12		8.84E-08
		Rt= 0.971	dT =	649.00 min				2.00	4.33 cc	4.15 cc	1.04	io =34.2		-17%
80	I	21.1	05/14/1999	20	0	0		2.00	99.20	9.15	p	231.22		9.46E-08
	F	21.4	05/15/1999	11	19	0		2.00	72.40	35.20	p	178.37		9.44E-08
		Rt= 0.974	dT =	919.00 min				2.00	6.27 cc	6.09 cc	1.03	io =34.5		-12%
81	I	21.4	05/15/1999	11	21	0		2.00	98.00	10.30	p	235.93		9.82E-08
	F	21.3	05/16/1999	12	28	0		2.20	55.30	51.80	p	151.73		9.77E-08
		Rt= 0.971	dT =	1507.00 min				2.10	9.99 cc	9.71 cc	1.03	io =35.2		-9%
82	I	21.3	05/16/1999	12	31	0		2.00	96.20	10.20	p	227.17		9.78E-08
	F	21.7	05/17/1999	9	33	0		2.00	61.00	45.00	p	157.17		9.70E-08
		Rt= 0.968	dT =	1262.00 min				2.00	8.23 cc	8.14 cc	1.01	io =33.9		-9%
83	I	21.7	05/17/1999	9	40	0		2.00	99.05	10.50	p	236.78		9.71E-08
	F	21.3	05/17/1999	17	56	0		2.20	83.10	26.25	p	205.08		9.63E-08
		Rt= 0.968	dT =	496.00 min				2.10	3.73 cc	3.68 cc	1.01	io =35.3		-10%
84	I	21.3	05/17/1999	18	2	0		2.00	98.90	10.05	p	230.02		9.50E-08
	F	21.6	05/18/1999	9	18	0		2.00	72.50	36.25	p	177.42		9.43E-08
		Rt= 0.969	dT =	916.00 min				2.00	6.17 cc	6.13 cc	1.01	io =34.3		-12%
85	I	21.6	05/18/1999	9	31	0		2.00	97.60	9.70	p	236.13		9.91E-08
	F	21.0	05/18/1999	17	59	0		2.20	80.95	26.00	p	203.18		9.88E-08
		Rt= 0.973	dT =	508.00 min				2.10	3.89 cc	3.81 cc	1.02	io =35.2		-8%
86	I	21.0	05/18/1999	18	4	0		2.00	98.90	10.90	p	229.17		9.61E-08
	F	21.7	05/19/1999	9	46	0		2.00	71.70	37.95	p	174.92		9.56E-08
		Rt= 0.971	dT =	942.00 min				2.00	6.36 cc	6.33 cc	1.01	io =34.2		-11%
87	I	21.7	05/19/1999	9	49	0		2.00	98.95	9.95	p	230.17		1.04E-07
	F	21.5	05/19/1999	17	14	0		2.00	84.15	24.80	p	200.52		1.03E-07

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.703 cm εαξιαλ =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or					
	x	with stones or		Stones with filter paper or		top + bottom			
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination					
5) Direction of permeant :	x	Up during or		Down during permeation					
3) During saturation: Water flushed up sides of specimen to remove air					x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or				Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or		0.005 N calcium sulfate (CaSO4)	

Cell No. H-2

Stage No : 4 sc 105.0 psi — System: p=pipette a = annulus b =both

Apparatus No. 7 Ub 100.0 psi — Head Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

(s'c)max= 5.0 psi (s'c)min= 2.8 psi 'c)av= 3.9 psi — Tail Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

Preliminary Length/A

Lo = 2.741
dLc= 0.102
Lc= 2.639
Lo= 6.962
Ao = 42.25
Vo = 294.14
Lc= 6.703
dVc = 3 Vo * (dLc/L
dVc= 32.84
Vc = 261.299
Ac= 38.984

Trial	Stage	Temp	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary	Permeability (cm/sec) Final at 20°C
		Rt= 0.965	dT =	445.00 min				2.00	3.46 cc	3.47 cc	1.00	io =34.3		-4%
88	I	21.5	05/19/1999	17	15	0		2.00	99.00	10.35	p	229.82		9.74E-08
	F	21.6	05/20/1999	9	18	0		2.00	70.80	38.25	p	173.72		9.64E-08
		Rt= 0.967	dT =	963.00 min				2.00	6.60 cc	6.53 cc	1.01	io =34.3		-10%
89	I	21.6	05/20/1999	9	25	0		2.00	98.95	10.55	p	229.57		8.80E-08
	F	21.0	05/20/1999	17	47	0		2.00	84.75	24.70	p	201.22		8.77E-08
		Rt= 0.973	dT =	502.00 min				2.00	3.32 cc	3.31 cc	1.00	io =34.2		-18%
90	I	21.0	05/20/1999	17	57	0		2.00	98.80	10.00	p	229.97		9.43E-08
	F	21.5	05/21/1999	9	18	0		2.00	72.10	35.80	p	177.47		9.41E-08
		Rt= 0.974	dT =	921.00 min				2.00	6.25 cc	6.03 cc	1.03	io =34.3		-12%
91	I	21.5	05/21/1999	9	21	0		2.00	99.20	10.00	p	219.78		9.23E-08
	F	21.0	05/21/1999	18	37	0		1.70	83.50	25.50	p	188.58		9.21E-08
		Rt= 0.974	dT =	556.00 min				1.85	3.67 cc	3.63 cc	1.01	io =32.8		-14%
92	I	21.0	05/21/1999	18	42	0		1.00	99.40	9.35	p	153.58		9.50E-08
	F	21.5	05/24/1999	10	29	0		0.80	48.20	59.80	p	51.93		9.47E-08
		Rt= 0.974	dT =	3827.00 min				0.90	11.98 cc	11.80 cc	1.01	io =22.9		-11%
93	I	21.5	05/24/1999	10	36	0		2.00	98.85	10.00	p	230.02		8.64E-08
	F	21.6	05/25/1999	9	29	0		2.00	64.55	44.30	p	161.42		8.56E-08
		Rt= 0.967	dT =	1373.00 min				2.00	8.02 cc	8.02 cc	1.00	io =34.3		-20%
94	I	21.6	05/25/1999	9	36	0		2.00	98.80	10.45	p	222.46		9.71E-08
	F	21.0	05/25/1999	18	13	0		1.80	83.30	25.90	p	191.51		9.68E-08
		Rt= 0.973	dT =	517.00 min				1.90	3.63 cc	3.61 cc	1.00	io =33.2		-9%
95	I	21.0	05/25/1999	18	15	0		2.00	98.95	10.00	p	244.23		9.62E-08
	F	21.0	05/26/1999	17	50	0		2.40	58.00	50.60	p	162.68		9.66E-08
		Rt= 0.980	dT =	1415.00 min				2.20	9.58 cc	9.50 cc	1.01	io =36.4		-10%
96	I	21.0	05/26/1999	17	56	0		2.00	98.95	10.35	p	247.41		1.01E-07
	F	21.2	05/27/1999	17	31	0		2.50	55.90	53.20	p	161.51		1.01E-07
		Rt= 0.978	dT =	1415.00 min				2.25	10.07 cc	10.02 cc	1.00	io =36.9		-5%
97	I	21.7	05/28/1999	17	38	0		1.00	99.40	10.05	p	145.82		9.23E-08
	F	21.5	06/01/1999	9	17	0		0.60	37.70	59.90	p	34.27		9.13E-08
		Rt= 0.965	dT =	5259.00 min				0.80	14.43 cc	11.66 cc	1.24	io =21.8		-15%
98	I	21.5	06/01/1999	9	33	0		2.00	98.60	10.80	p	214.85		9.35E-08
	F	21.5	06/02/1999	16	37	0		1.60	54.00	53.30	p	127.75		9.27E-08
		Rt= 0.968	dT =	1864.00 min				1.80	10.43 cc	9.94 cc	1.05	io =32.1		-13%
99	I	21.5	06/02/1999	16	56	0		2.00	98.40	10.65	p	228.92		9.00E-08
	F	21.5	06/03/1999	18	12	0		2.00	59.50	48.30	p	152.37		8.92E-08
		Rt= 0.968	dT =	1516.00 min				2.00	9.10 cc	8.81 cc	1.03	io =34.2		-17%
100	I	21.5	06/03/1999	18	19	0		2.00	98.60	10.55	p	229.22		9.20E-08
	F	21.1	06/04/1999	17	56	0		2.00	61.05	46.85	p	155.37		9.16E-08
		Rt= 0.973	dT =	1417.00 min				2.00	8.78 cc	8.49 cc	1.03	io =34.2		-14%
101	I	21.1	06/04/1999	18	7	0		1.00	99.20	10.15	p	159.63		8.26E-08
	F	21.7	06/07/1999	10	20	0		1.00	49.10	57.90	p	61.78		8.21E-08
		Rt= 0.970	dT =	3853.00 min				1.00	11.72 cc	11.17 cc	1.05	io =23.8		-23%
102	I	21.7	06/07/1999	10	33	0		2.00	98.50	10.15	p	229.52		1.01E-07

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.703 cm εαξιαλ =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in:	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant:	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used: Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No.	H-2				
Stage No.:	4	sc	105.0	psi	System: p=pipette a = annulus b =both
Apparatus No.	7	Ub	100.0	psi	Head Tube Area = 0.2339 0.0000 0.0000 cm2 cm2
(s'c)max= 5.0 psi	(s'c)min= 2.8 psi	'c)av= 3.9 psi			Tail Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

Preliminary Length/A

Lo = 2.741
dLc= 0.102
Lc= 2.639
Lo= 6.962
Ao = 42.25
Vo = 294.14
Lc= 6.703
dVc = 3 Vo * (dLc/L
dVc= 32.84
Vc = 261.299
Ac= 38.984

Trial	Stage	Temp.	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary Final at 20°C
	F	23.0	06/08/1999	18	58	0		2.00	47.05	60.40	p	127.82	9.78E-08
		Rt= 0.947	dT =	1945.00 min				2.00	12.03 cc	11.75 cc	1.02	io =34.2	-8%
103	I	23.0	06/08/1999	17	7	0		2.00	98.80	10.50	p	229.47	8.82E-08
	F	22.0	06/09/1999	18	42	0		2.00	60.15	48.10	p	153.22	8.52E-08
		Rt= 0.943	dT =	1535.00 min				2.00	9.04 cc	8.79 cc	1.03	io =34.2	-20%
104	I	22.0	06/09/1999	18	48	0		2.00	98.75	10.25	p	236.73	9.74E-08
	F	21.3	06/10/1999	18	47	0		2.20	57.90	50.30	p	155.83	9.62E-08
		Rt= 0.964	dT =	1439.00 min				2.10	9.55 cc	9.37 cc	1.02	io =35.3	-10%
105	I	21.3	06/10/1999	18	55	0		2.00	99.05	11.10	p	229.12	9.41E-08
	F	21.3	06/11/1999	18	24	0		2.00	61.35	48.25	p	154.27	9.37E-08
		Rt= 0.973	dT =	1409.00 min				2.00	8.82 cc	8.69 cc	1.01	io =34.2	-12%
106	I	21.3	06/11/1999	18	28	0		2.00	99.20	10.40	p	229.97	9.58E-08
	F	21.4	06/12/1999	12	12	0		2.00	68.95	40.45	p	169.67	9.53E-08
		Rt= 0.971	dT =	1064.00 min				2.00	7.08 cc	7.03 cc	1.01	io =34.3	-11%
107	I	21.4	06/12/1999	12	15	0		2.00	98.00	10.20	p	228.97	1.02E-07
	F	21.3	06/14/1999	9	15	0		2.00	31.45	72.20	p	100.42	1.02E-07
		Rt= 0.971	dT =	2700.00 min				2.00	15.57 cc	14.50 cc	1.07	io =34.2	-5%
108	I	21.3	06/14/1999	9	30	0		2.00	98.70	10.85	p	229.02	8.10E-08
	F	21.3	06/15/1999	19	3	0		2.00	54.10	54.50	p	140.77	8.07E-08
		Rt= 0.973	dT =	2013.00 min				2.00	10.43 cc	10.21 cc	1.02	io =34.2	-24%
109	I	21.3	06/15/1999	19	24	0		2.00	99.00	9.10	p	231.07	8.99E-08
	F	21.3	06/16/1999	17	12	0		2.00	64.15	42.60	p	162.72	8.95E-08
		Rt= 0.973	dT =	1308.00 min				2.00	8.15 cc	7.84 cc	1.04	io =34.5	-16%
110	I	21.3	06/16/1999	17	24	0		2.00	98.90	11.00	p	229.07	9.40E-08
	F	21.2	06/17/1999	18	58	0		2.00	58.20	50.40	p	148.97	9.38E-08
		Rt= 0.974	dT =	1534.00 min				2.00	9.52 cc	9.22 cc	1.03	io =34.2	-12%
111	I	21.2	06/17/1999	19	6	0		2.00	99.00	10.50	p	229.67	9.90E-08
	F	21.2	06/18/1999	16	4	0		2.00	63.10	45.90	p	158.37	9.89E-08
		Rt= 0.975	dT =	1258.00 min				2.00	8.40 cc	8.28 cc	1.01	io =34.3	-7%
112	I	21.2	06/18/1999	16	9	0		2.00	98.90	10.55	p	229.52	1.08E-07
	F	21.7	06/20/1999	12	5	0		2.00	33.40	76.35	p	98.22	1.07E-07
		Rt= 0.969	dT =	2636.00 min				2.00	15.32 cc	15.39 cc	1.00	io =34.2	0%
113	I	21.7	06/20/1999	12	12	0		2.00	98.50	10.40	p	229.27	1.11E-07
	F	21.2	06/21/1999	18	11	0		2.00	46.75	61.60	p	126.32	1.10E-07
		Rt= 0.969	dT =	1799.00 min				2.00	12.10 cc	11.98 cc	1.01	io =34.2	3%
114	I	21.2	06/21/1999	18	15	0		2.00	98.85	10.60	p	229.42	1.11E-07
	F	21.9	06/22/1999	18	6	0		2.00	55.35	54.00	p	142.52	1.10E-07
		Rt= 0.967	dT =	1431.00 min				2.00	10.17 cc	10.15 cc	1.00	io =34.2	3%
115	I	21.9	06/22/1999	18	12	0		2.00	96.20	10.05	p	227.32	9.35E-08
	F	22.2	06/23/1999	18	50	0		2.00	59.10	49.75	p	150.52	9.14E-08
		Rt= 0.954	dT =	1478.00 min				2.00	8.68 cc	9.29 cc	0.93	io =33.9	-15%
116	I	22.2	06/23/1999	18	52	0		2.00	99.10	10.05	p	230.22	1.05E-07
	F	22.2	06/24/1999	17	42	0		2.00	58.65	50.00	p	149.82	1.02E-07
		Rt= 0.951	dT =	1370.00 min				2.00	9.46 cc	9.34 cc	1.01	io =34.3	-4%

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.703 cm εαξιαλ =

PERMEABILITY TEST: FALLING HEAD - INCREASING TAILWATER

ASTM D 5084 - 90

Specimen - Apparatus set-up - Test Information

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
5) Direction of permeant :	x	Up during or		Down during permeation			
3) During saturation: Water flushed up sides of specimen to remove air:			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
6) Permeant used : Impacted GW		Demineralized		Distilled		Tap or	0.005 N calcium sulfate (CaSO4)

Cell No. H-2

Stage No. 4 sc 105.0 psi — System: p=pipette a = annulus b =both

Apparatus No. 7 Ub 100.0 psi — Head Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

(s'c)max= 5.0 psi (s'c)min= 2.8 psi 'c)av= 3.9 psi — Tail Tube Area = 0.2339 0.0000 0.0000 cm2 cm2

Preliminary Length/A

Lo = 2.741
dLc= 0.102
Lc= 2.639
Lo= 6.962
Ao = 42.25
Vo = 294.14
Lc= 6.703
dVc = 3 Vo * (dLc/L
dVc= 32.84
Vc = 261.299
Ac= 38.984

Trial	Stage	Temp	Time				Pressure Head Reading Mercury	Pressure Head Reading Gage	Fluid Head Reading Head	Fluid Head Reading Tail	Burette Flow Ratio	Total Head (cm H2O)	Permeability (cm/sec) Preliminary	Permeability (cm/sec) Final at 20°C
117	I	22.2	06/24/1999	17	53	0		2.00	98.75	10.85	p	229.07		1.07E-07
	F	22.2	06/25/1999	17	2	0		2.00	57.50	51.60	p	147.07		1.04E-07
		Rt= 0.951	dT =	1389.00	min			2.00	9.65 cc	9.53 cc	1.01	io =34.2		-3%
118	I	22.2	06/25/1999	17	17	0		2.00	98.95	11.15	p	228.97		1.09E-07
	F	21.6	06/26/1999	11	50	0		2.00	63.80	45.80	p	159.17		1.07E-07
		Rt= 0.958	dT =	1113.00	min			2.00	8.22 cc	8.10 cc	1.01	io =34.2		1%
119	I	21.6	06/26/1999	12	1	0		2.00	98.60	9.85	p	229.92		1.17E-07
	F	21.4	06/28/1999	8	20	0		2.00	29.00	79.50	p	90.67		1.16E-07
		Rt= 0.968	dT =	2659.00	min			2.00	16.28 cc	16.29 cc	1.00	io =34.3		9%
120	I	21.4	06/28/1999	8	52	0		2.00	97.90	10.70	p	228.37		1.15E-07
	F	21.6	06/29/1999	18	0	0		2.00	41.40	66.90	p	115.67		1.14E-07
		Rt= 0.968	dT =	1988.00	min			2.00	13.22 cc	13.15 cc	1.01	io =34.1		6%
121	I	21.6	06/29/1999	18	8	0		2.00	98.90	11.35	p	228.72		1.14E-07
	F	21.5	06/30/1999	16	20	0		2.00	56.90	52.90	p	145.17		1.13E-07
		Rt= 0.967	dT =	1332.00	min			2.00	9.82 cc	9.72 cc	1.01	io =34.1		6%
122	I	21.5	06/30/1999	16	31	0		2.00	98.95	11.35	p	228.77		1.11E-07
	F	21.5	07/01/1999	18	5	0		2.00	53.30	56.75	p	137.72		1.10E-07
		Rt= 0.968	dT =	1534.00	min			2.00	10.68 cc	10.62 cc	1.01	io =34.1		3%
123	I	21.5	07/01/1999	18	13	0		2.00	99.00	10.70	p	229.47		8.96E-08
	F	21.9	07/02/1999	17	52	0		2.00	62.70	46.85	p	157.02		8.84E-08
		Rt= 0.963	dT =	1419.00	min			2.00	8.49 cc	8.46 cc	1.00	io =34.2		-17%
124	I	21.9	07/02/1999	17	59	0		1.00	99.20	10.20	p	159.58		9.87E-08
	F	21.5	07/03/1999	11	39	0		1.00	77.25	31.05	p	116.78		9.74E-08
		Rt= 0.963	dT =	1060.00	min			1.00	5.13 cc	4.88 cc	1.05	io =23.8		-9%
130	I	27.2	07/06/1999	12	37	0		2.00	99.00	9.35	p	230.82		1.40E-07
	F	24.3	07/07/1999	15	17	0		2.00	42.00	64.80	p	118.37		1.24E-07
		Rt= 0.864	dT =	1600.00	min			2.00	13.33 cc	12.97 cc	1.03	io =34.4		16%
131	I	24.3	07/07/1999	15	23	0		2.00	98.60	10.00	p	229.77		1.24E-07
	F	21.8	07/08/1999	18	20	0		2.00	46.25	61.40	p	126.02		1.19E-07
		Rt= 0.930	dT =	1617.00	min			2.00	12.24 cc	12.02 cc	1.02	io =34.3		11%
132	I	21.8	07/08/1999	18	23	0		2.00	99.20	10.75	p	229.62		1.19E-07
	F	21.5	07/09/1999	17	56	0		2.00	53.90	55.85	p	139.22		1.17E-07
		Rt= 0.964	dT =	1413.00	min			2.00	10.60 cc	10.55 cc	1.00	io =34.3		10%
133	I	21.5	07/09/1999	18	11	0		1.00	99.60	10.60	p	159.58		1.05E-07
	F	20.6	07/10/1999	12	4	0		1.00	76.70	33.30	p	113.98		1.05E-07
		Rt= 0.979	dT =	1073.00	min			1.00	5.36 cc	5.31 cc	1.01	io =23.8		-1%
134	I	20.6	07/10/1999	12	12	0		1.00	98.60	10.00	p	159.18		1.18E-07
	F	20.8	07/12/1999	18	16	0		1.00	43.80	63.80	p	50.58		1.20E-07
		Rt= 0.987	dT =	3244.00	min			1.00	12.82 cc	12.58 cc	1.02	io =23.7		12%

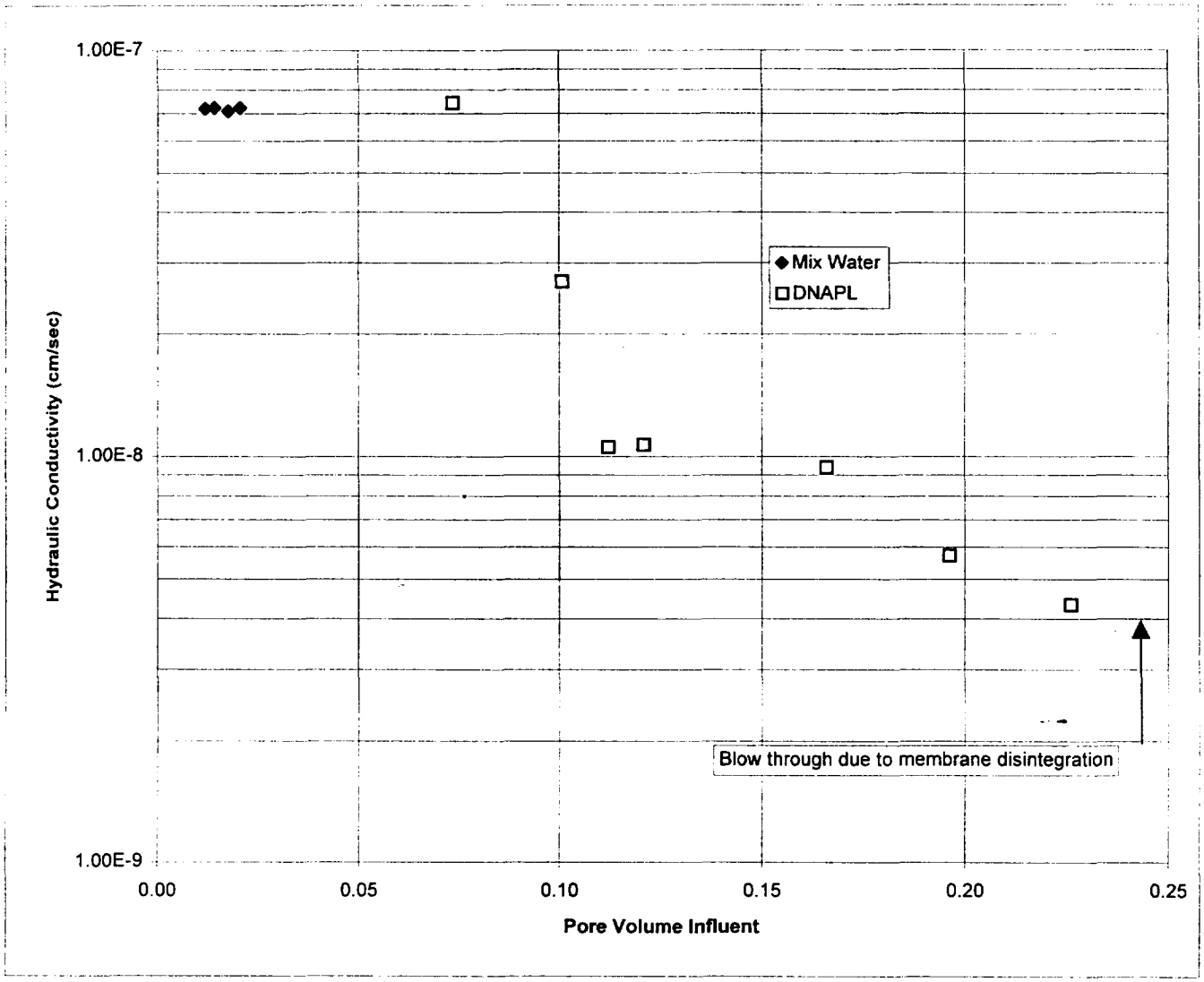
TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.703 cm εαξιαλ =

Project No. 3808E06011
Project Name: DETREX
Boring No. Composite
Sample No. Attapulgite
3% dry

Test No.: p5676.xls



PERMEABILITY TEST SUMMARY
ASTM D5084

Project No. 3808E06011
Project Name: DETREX

Boring No. Composite
Sample No. Attapulgite 3% dry

Test No.: p5676.xls
Volume Voids 112.5 cm^3

Stage	Permeant Type	Maximum Confining Stress (psi)	Gradient	Date	Influent Qstage (cc)	Influent Qtotal (cc)	Influent Pore Volumes Influent	Effluent Qstage (cc)	Effluent Qtotal (cc)	Sum Water In (cc)	Hydraulic Conductivity (cm/sec)
1	Site Mix	5	25.3	05/19/99	0.2	0.2	0.00	0.2	0.2	0.0	8.79E-8
2	Site Mix	5	26.0	05/19/99	0.2	0.5	0.00	0.2	0.4	0.0	8.79E-8
3	Site Mix	5	26.1	05/19/99	0.3	0.7	0.01	0.3	0.7	0.0	8.84E-8
4	Site Mix	5	26.1	05/19/99	0.4	1.1	0.01	0.4	1.1	0.0	8.65E-8
1	Site Mix	10	31.3	05/20/99	0.2	1.3	0.01	0.2	1.3	0.0	7.20E-8
2	Site Mix	10	32.5	05/20/99	0.3	1.6	0.01	0.3	1.6	0.0	7.23E-8
3	Site Mix	10	33.4	05/20/99	0.4	2.0	0.02	0.4	2.0	0.0	7.10E-8
4	Site Mix	10	34.7	05/20/99	0.3	2.3	0.02	0.3	2.3	0.0	7.23E-8
1	DNAPL	10	35.8	05/24/99	8.3	8.3	0.07	7.1	7.1	1.2	7.43E-8
2	DNAPL	10	35.9	05/25/99	3.1	11.3	0.10	3.2	10.3	1.1	2.70E-8
3	DNAPL	10	35.9	05/26/99	1.3	12.6	0.11	1.3	11.6	1.0	1.05E-8
4	DNAPL	10	35.9	05/27/99	1.0	13.6	0.12	1.5	13.2	0.5	1.07E-8
5	DNAPL	10	46.7	05/28/99	5.1	18.7	0.17	6.2	19.3	-0.6	9.39E-9
6	DNAPL	10	46.7	06/01/99	3.4	22.1	0.20	1.7	21.1	1.0	5.71E-9
7	DNAPL	10	46.6	06/04/99	3.4	25.4	0.23	3.3	24.3	1.1	4.32E-9

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 3808E06011 | BORING: Composite | Test No.: P5676

Project Name: DETREX | Additive: Attapulgite

Specimen - Apparatus set-up - Test Information | Cell No. H-6 | Apparatu 8 | Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.725	in	Lo=	6.922	cm
dLc=	0.139	in	Ao =	43.78	cm2
Lc=	2.586	in	Vo =	303.00	cm3
			Lc=	6.569	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	46.37	cm3
			Vc =	256.64	cm3
Sc =	0.168	cm-1	Ac=	39.070	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or			top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes			
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used		Tap		Distilled			
or MIX WATER		Demineralized		0.005 N calcium sulfate (CaSO4)			

Equations Used

Kt = - 0.0000785 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.3507

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	Time min	Time sec	Initial sc psi	Initial Ub psi	U-tube Reading Head (cm) (cc)	U-tube Reading Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.7	05/20/1999	09	54	00	110.0	100.0	60.80	44.45	1.01	7.40E-08
final	21.6	05/20/1999	10	39	00			58.10	45.39		7.20E-08
1	RT = 0.964	dT =		45.00 min		s'c =	1.4 ksf	0.216	0.214	io= 31.3	0%
initial	21.6	05/20/1999	10	41	00	110.0	100.0	61.25	44.28	1.01	7.43E-08
final	21.6	05/20/1999	11	34	00			58.01	45.41		7.23E-08
2	RT = 0.965	dT =		53.00 min		s'c =	1.4 ksf	0.259	0.258	io= 32.5	1%
initial	21.6	05/20/1999	11	35	00	110.0	100.0	61.61	44.15	1.01	7.26E-08
final	21.3	05/20/1999	13	00	00			56.78	45.82		7.10E-08
3	RT = 0.969	dT =		85.00 min		s'c =	1.4 ksf	0.386	0.381	io= 33.4	-1%
initial	21.3	05/20/1999	13	02	00	110.0	100.0	62.12	43.98	0.99	7.37E-08
final	21.3	05/20/1999	14	09	00			57.93	45.46		7.23E-08
4	RT = 0.973	dT =		67.00 min		s'c =	1.4 ksf	0.335	0.338	io= 34.7	1%

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.569	cm	ξιαλ =	5.1%	
Ac =	38.720	cm2			
Vc=	254.34	cm3	εωολ =	16.1%	
Sc =	0.170	cm-1	Sc = Lc / Ac , final		

	w (%)	γτ (pcf)	γδ (pcf)	S (%)
Initial	40.76	114.3	81.2	99.7
PreTest	28.54	124.4	96.8	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **7.19E-08** cm/sec

(io)ave = 33.0

Tested By: BB Reviewed By: G. Thomas

Attachment 4-C

Bentonite-Water Slurry Mix and

Index Compatibility Test Summary

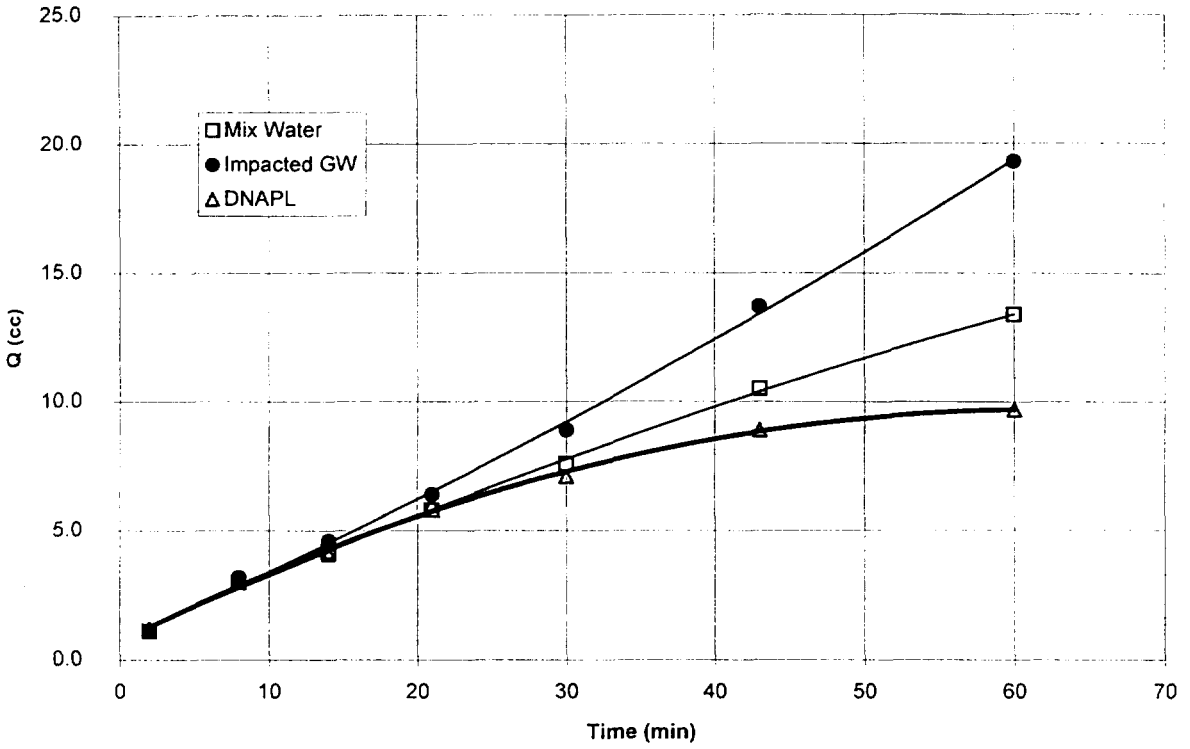
BENTONITE-WATER SLURRY MIX and INDEX COMPATABILITY TEST SUMMARY SHEET

Slurry Mix No.	Ratio of additive to water by wgt (%)	Constituents		Marsh Funnel Viscosity initial / after hyd. (sec)	Mud Balance Density initial / after hyd. (pcf)	pH	Filter Press		Filtrate Loss Response with Imp. GW / with DNAPL	Sedimentation Response with Imp. GW	Dessication Response with Imp. GW	Remarks
		Mix Water (type)	Bentonite (type)				flow at 31 min (ml)	Filter Cake (in)				
1	5.75	Site	FedJel	*	*	10.0	17.6	1/8"	Marginal	Good	No clumps	*diluted from
		Mix	Barakade 90	42	64.5				Good	No flocculation	No cracks	6% mix
2	2.64	Site	Wyo-Ben	37	63.4	10.0	14.6	1/32"	OK	Bad	Clumped	
		Mix	SW101	38	63.5				Good	Strong flocculation	No cracks	
3	6.00	Site	Floridin	36	64.4	10.1	111.4	1/4"	Good	OK	No clumps	
		Mix	Attapulgite	38	64.5				Questionable	Some flocculation	No cracks	

BENTONITE SCREENING PLASTICITY INDEX COMPATABILITY TEST SUMMARY

ADDITIVE TYPE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		MATERIAL EVALUATION
FedJel	478	32	446	mix water	Poor
Barakade 90	330	21	309	impacted water	
Wyo-Ben	810	57	753	mix water	Good
SW101	913	99	814	impacted water	
Floridin	294	86	208	mix water	Good
Attapulgite	310	87	223	impacted water	

Filter Press Slurry Compatability Test
Slurry Mix 1: 5.75 % Barakade 90



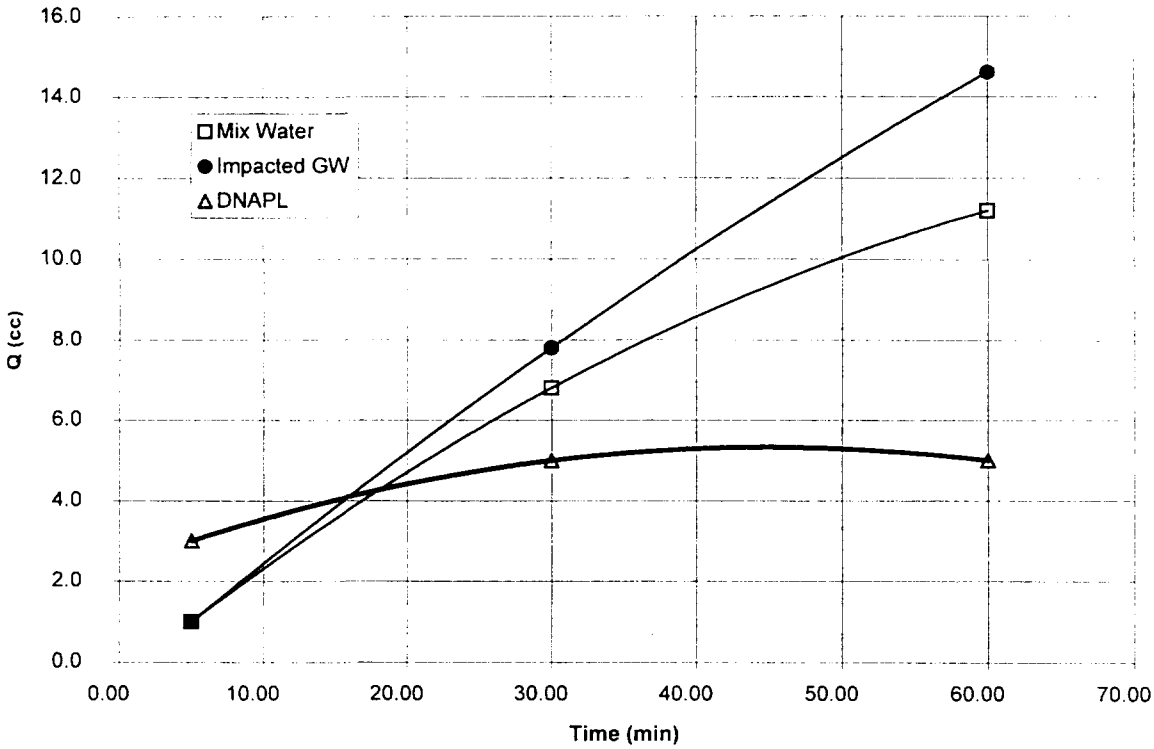
	mix water		Impacted GW		DNAPL	
	Elapsed Time (min)	ΔQ (cc)	Elapsed Time (min)	ΔQ (cc)	Elapsed Time (min)	ΔQ (cc)
	2	1.1	2	1.1	2	1.2
	8	3.0	8	3.2	8	3.0
	14	4.2	14	4.6	14	4.1
	21	5.8	21	6.4	21	6.0
	30	7.6	30	8.9	30	7.1
	43	10.5	43	13.7	43	8.9
Cake Characteristics	60	13.4	60	19.3	60	9.7
Thickness (inch):	1/8"		13/64"		3/64"	
Water Content (%):	508		673		161	
Description:	Intact		loose		Intact	

Remarks: No Visible DNAPL leachate

Reviewed By: 12/21/99

Project No. 8E06011	DETREX SITE Design Tests	Effect of Permeant on Flow Rates with Barakade 90 Slurry
URS GREINER WOODWARD CLYDE		

Filter Press Slurry Compatability Test
Slurry Mix 2: 2.64% SW101



mix water		Impacted GW		DNAPL	
Elapsed Time (min)	ΔQ (cc)	Elapsed Time (min)	ΔQ (cc)	Elapsed Time (min)	ΔQ (cc)
5.00	1.0	5.00	1.0	5.00	3.0
30.00	6.8	30.00	7.8	30.00	5.0
60.00	11.2	60.00	14.6	60.00	5.0

Cake Characteristics

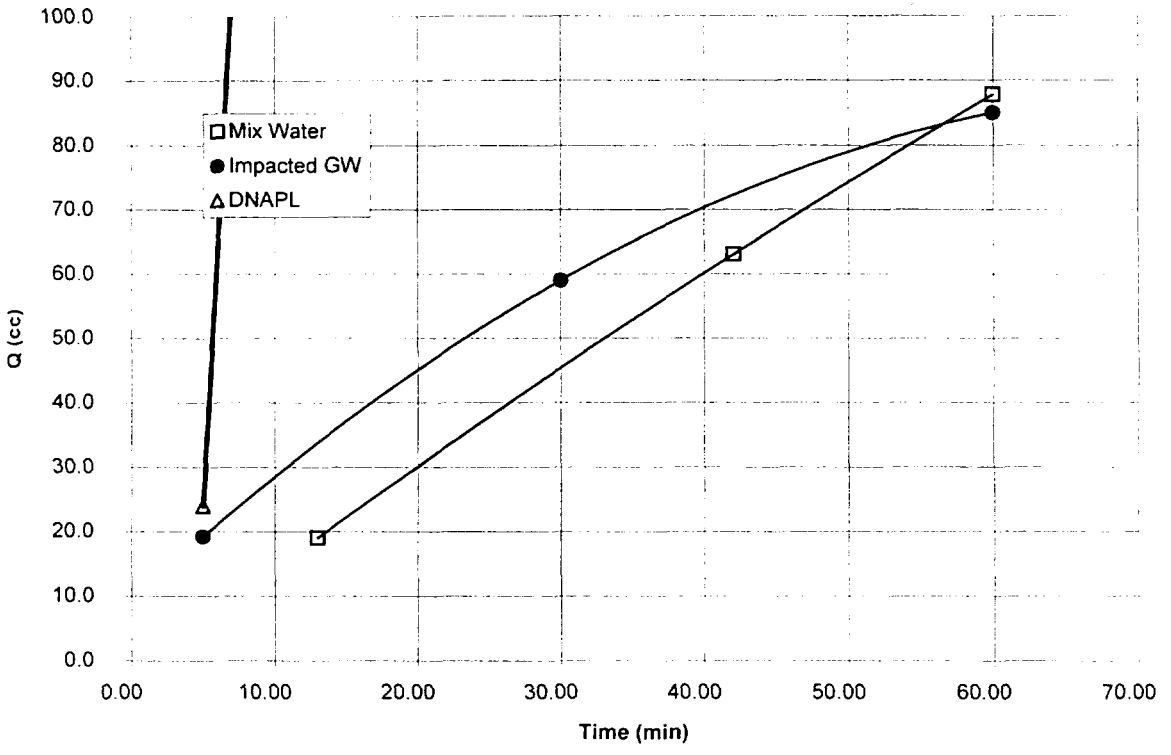
Thickness (inch):	1/32"	1/16"	1/64"
Water Content (%):	419	842	167
Description:	Intact	loose	Intact

Remarks: Visible DNAPL leachate after 1 minute, no flow for DNAPL after 5 minutes

Reviewed By: 12/21/99

Project No. 8E06011	DETREX SITE Design Tests	Effect of Permeant on Flow Rates with SW101 Slurry
URS GREINER WOODWARD CLYDE		

Filter Press Slurry Compatability Test
Slurry Mix 3: 6 % Attapulgite



mix water		Impacted GW		DNAPL	
Elapsed Time (min)	ΔQ (cc)	Elapsed Time (min)	ΔQ (cc)	Elapsed Time (min)	ΔQ (cc)
13.00	19.0	5.00	19.2	5.00	24.0
42.00	63.0	30.00	59.0	30.00	
60.00	87.8	60.00	85.0	60.00	

Cake Characteristics

Thickness (inch):	1/4"	9/32"	1/8"
Water Content (%):	301	288	160
Description:	Intact	loose	Intact (cracked)

Remarks: Rapid DNAPL breakthrough with subsequent free flow

Reviewed By: 12/21/99

Project No. 8E06011	DETREX SITE Design Tests	Effect of Permeant on Flow Rates with Attapulgite Slurry
URS GREINER WOODWARD CLYDE		

Sample	**Slurry Mix 1**							
Sample Area: A=	6.90 cm^2		Sample Height: L=	0.094 cm				
Date	**Time**	**Elapsed Time (min)**	**Pressure (psi)**	**ΔQ (cc)**	**Permeant**	**PV**	**ΔQ/Δt**	
########	13:20	6	100	3.2	tap water		0.533	
		10		4	tap water		0.400	0.2
		18		5.5	tap water		0.306	0.1875
		26		7.2	tap water		0.277	0.2
		31		8	tap water		0.258	0.194186
		47		10.8	tap water		0.230	0.172299
		65		13.8	tap water		0.212	0.170507
		90		18.2	tap water		0.202	0.172337
		122		23.4	tap water		0.192	0.16815
		131		25	tap water		0.191	0.164968
		150		28.5	tap water		0.190	0.182463
		184		34	tap water		0.185	0.168863
Vv=	-25.76822		Vc=	0.646875				
			Gs=	2.65				
			Wet initial=	210				
			Wo=	200				

Sample	**Slurry Mix 1**									
Sample Area: A=	0.00 cm^2	Sample Height: L=	0.094 cm							
Date	**Time**	**Elapsed Time (min)**	**Pressure (psi)**	**ΔQ (cc)**	**Permeant**	**PV**	**ΔQ/Δt**	leachate/tap		
########	13:20	8	100	3.1	Leachate		0.388	0.727		
		10		3.6	Leachate		0.360	0.900	0.25	1.25
		18		5.4	Leachate		0.300	0.982	0.225	1.2
		27		7	Leachate		0.259	0.936	0.199539	0.997696
		32		8.2	Leachate		0.256	0.993	0.197351	1.016299
		47		12.2	Leachate		0.260	1.130	0.261538	1.517932
		65		16.8	Leachate		0.258	1.217	0.26044	1.527443
		90		23.7	Leachate		0.263	1.302	0.267977	1.554956
		95		25	Leachate		0.263	1.372	0.274194	1.630646
		121		31	Leachate		0.256	1.342	0.233935	1.418066
		150		39.8	Leachate		0.265	1.396	0.269749	1.478374
		184		48.9	Leachate		0.266	1.438	0.283657	1.679811

Attachment 4-D

Bulk Soil Index Data Summary

BULK SOIL INDEX DATA SUMMARY

BORING NO.	IDENTIFICATION TESTS										REMARKS
	WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB.	SIEVE MINUS NO. 200 (%)	HYDROMETER % MINUS 2 μm (%)	pH	ORGANIC CONTENT (burnoff) (%)	SPECIFIC GRAVITY	
RMI		26	16	10	CL	95.2	19				
S		26	17	9	CL	95.3	19				
W		29	18	11	CL	94.5	21				

BENTONITE SCREENING INDEX COMPATABILITY TEST SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS										REMARKS
			WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB.	SIEVE MINUS NO. 200 (%)	HYDROMETER % MINUS 2 μm (%)	pH	ORGANIC CONTENT (burnoff) (%)	SPECIFIC GRAVITY	
Barakade 90				478	32	446	CH						mix water
				330	21	309	CH						impacted water
SW101				810	57	753	CH						mix water
				913	99	814	CH						impacted water
Attapulgite				294	86	208	CH						mix water
				310	87	223	CH						impacted water

Reviewed by: _____ Date: 12/21/1999

Project No.: 8E06011

Attachment 4-E

Summary of Soil Additive Hydraulic Conductivity Testing

Design Mix Selection Tests

SUMMARY OF SOIL-ADDITIVE HYDRAULIC CONDUCTIVITY TESTING
DESIGN MIX SELECTION TESTS

SOIL TYPE/ ADDITIVE TYPE	ADDITIVE ADDED DRY (By Dry Weight) (%)	TOTAL RATIO ADDITIVE: SOIL (By Dry Weight) (%)	WATER CONTENTS INITIAL PRE-TEST (%)	TOTAL UNIT WGTS. INITIAL PRE-TEST (pcf)	DRY UNIT WGTS. INITIAL PRE-TEST (pcf)	STRESSES EFFECTIVE BACK PRESSURE (psi)	DURING CONSOL. TIME VOLUMETRIC STRAIN (days/%)	DURING TEST PERMEANT INITIAL GRADIENT	COEFFICIENT OF PERM. K, (@ 20 C) (cm/sec)	REMARKS
Soil Composite / Barakade 90	0.00	1.08	38.0	115.9	84.0	5.0	2	tap water	1.31E-07	
			25.5	126.7	100.9	100.0	16.8	20		
Soil Composite / Barakade 90	1.00	1.94	36.0	117.3	86.3	5.0	2	tap water	1.03E-07	
			25.5	126.7	101.0	100.0	14.6	21		
Soil Composite / Barakade 90	3.00	4.08	37.0	116.4	85.0	5.0	2	Tap	6.27E-08	Test continued for compatability study
			27.2	124.9	98.2	100.0	13.4	20		
Soil Composite / SW 101	0.00	0.50	38.3	115.7	83.7	5.0	2	tap water	2.68E-07	
			26.4	125.7	99.4	100.0	15.9	19		
Soil Composite / SW 101	1.00	1.64	43.1	112.2	78.4	5.0	2	tap water	1.27E-07	
			29.3	122.9	95.0	100.0	17.5	20		
Soil Composite / SW 101	3.00	3.80	47.7	109.0	73.8	5.0	2	Tap	5.82E-08	Test continued for compatability study
			31.4	121.1	92.2	100.0	19.9	21		
Soil Composite / Attapulgite	0.00	1.00	36.2	117.8	86.5	5.0	2	tap water	1.29E-07	
			25.5	127.5	101.6	100.0	14.9	19		
Soil Composite / Attapulgite	1.00	2.09	37.1	117.2	85.5	5.0	2	tap water	1.32E-07	
			26.3	126.7	100.3	100.0	14.8	20		
Soil Composite / Attapulgite	3.00	4.17	37.9	116.6	84.6	5.0	1	Tap	8.98E-08	Test continued for compatability study
			28.1	124.8	97.5	100.0	13.2	19		

Prepared by: ___ Reviewed by: _____ Date: 12/21/1999

SUMMARY OF SOIL-ADDITIVE HYDRAULIC CONDUCTIVITY TESTING
DESIGN MIX SELECTION TESTS

SOIL TYPE/ ADDITIVE TYPE	ADDITIVE ADDED DRY (By Dry Weight) (%)	TOTAL RATIO ADDITIVE: SOIL (By Dry Weight) (%)	WATER CONTENTS INITIAL PRE-TEST (%)	TOTAL UNIT WGTS. INITIAL PRE-TEST (pcf)	DRY UNIT WGTS. INITIAL PRE-TEST (pcf)	STRESSES EFFECTIVE BACK PRESSURE (psi)	DURING CONSOL. TIME VOLUMETRIC STRAIN (days/%)	DURING TEST PERMEANT INITIAL GRADIENT	COEFFICIENT OF PERM. K, (@ 20 C) (cm/sec)	REMARKS

Notes: Pre-test is at the start of permeation.

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 BORING: Composite / Barakade Test No.: P5310

Project Name: SAMPLE: 1% via slurry DEPTH (ft): 0% dry

Specimen - Apparatus set-up - Test Information Cell No. H-4 Apparatus No. 1 Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.685	in	Lo=	6.820	cm		
dLc=	0.075	in	Ao =	42.32	cm2		
Lc=	2.610	in	Vo =	288.63	cm3		
			Lc=	6.629	cm		
dVc = 3 Vo * (dLc/Lo)			dVc=	24.19	cm3		
			Vc =	264.44	cm3		
Sc =	0.166	cm-1	Ac=	39.890	cm2		

Equations Used

Kt = - 0.0000760 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.319

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or	
	x	with stones or		Stones with filter paper or	top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination	
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top	Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation	
6) Permeant: water used	x	Tap		Distilled	
or		Demineralized		0.005 N calcium sulfate (CaSO4)	

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.629	cm	ε_{axial} = 2.8%
Ac =	36.225	cm2	
Vc=	240.15	cm3	ε_{vol} = 16.8%
Sc =	0.183	cm-1	Sc = Lc / Ac , final

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	38.03	115.9	84.0	100.0
PreTest	25.55	126.7	100.9	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **1.31E-07** cm/sec

(io)ave = 20.2

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. °C	Date	Time hr	min	sec	Initial sc psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.4	03/10/1999	09	13	00	105.0	100.0	52.70	42.27	1.03	1.22E-07
final	21.4	03/10/1999	09	56	00			50.02	43.10		1.30E-07
1	RT = 0.970	dT =	43.00 min			s'c =	0.7 ksf	0.203	0.197	io= 19.8	-1%
initial	21.4	03/10/1999	09	59	00	105.0	100.0	52.95	42.18	1.02	1.23E-07
final	21.4	03/10/1999	11	31	00			48.11	43.70		1.32E-07
2	RT = 0.970	dT =	92.00 min			s'c =	0.7 ksf	0.366	0.360	io= 20.4	1%
initial	21.4	03/10/1999	11	35	00	105.0	100.0	53.03	42.15	1.01	1.23E-07
final	21.3	03/10/1999	12	42	00			49.08	43.40		1.31E-07
3	RT = 0.971	dT =	67.00 min			s'c =	0.7 ksf	0.299	0.296	io= 20.6	0%
initial	21.3	03/10/1999	12	45	00	105.0	100.0	52.82	42.22	1.03	1.22E-07
final	21.3	03/10/1999	13	52	00			49.00	43.40		1.30E-07
4	RT = 0.973	dT =	67.00 min			s'c =	0.7 ksf	0.289	0.280	io= 20.1	0%
initial											
final											
5		dT =				s'c =					
initial											
final											
6		dT =				s'c =					

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 | BORING: Composite / Barakade | Test No.: P5313

Project Name: | SAMPLE: 1% via slurry DEPTH (ft): 1% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-3 | Apparatus No. 2 | Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.722	in	Lo=	6.915 cm
dLc=	0.053	in	Ao =	42.52 cm2
Lc=	2.669	in	Vo =	294.02 cm3
			Lc=	6.780 cm
dVc = 3 Vo * (dLc/Lo)			dVc=	17.17 cm3
			Vc =	276.85 cm3
Sc =	0.166	cm-1	Ac=	40.833 cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes		
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation		
6) Permeant: water used	x	Tap		Distilled		
or		Demineralized		0.005 N calcium sulfate (CaSO4)		

Equations Used

Kt = - 0.0000752 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.322

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.780	cm	ε_{axial} =	1.9%
Ac =	37.055	cm2		
Vc=	251.23	cm3	ε_{vol} =	14.6%
Sc =	0.183	cm-1	Sc = Lc / Ac , final	

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	35.99	117.3	86.3	100.0
PreTest	25.47	126.7	101.0	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **1.03E-07** cm/sec

(io)ave = 21.0

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. °C	Date	Time hr	min	sec	Initial sc psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.4	03/10/1999	09	14	00	105.0	100.0	57.68	46.68	1.03	9.73E-08
final	21.4	03/10/1999	09	57	00			55.31	47.42		1.04E-07
1	RT = 0.970	dT =	43.00 min			s'c =	0.7 ksf	0.178	0.172	io= 20.4	1%
initial	21.4	03/10/1999	10	00	00	105.0	100.0	58.07	46.56	1.00	9.67E-08
final	21.4	03/10/1999	11	33	00			53.60	48.00		1.03E-07
2	RT = 0.970	dT =	93.00 min			s'c =	0.7 ksf	0.335	0.335	io= 21.3	0%
initial	21.4	03/10/1999	11	36	00	105.0	100.0	58.07	46.56	1.02	9.65E-08
final	21.3	03/10/1999	12	44	00			54.51	47.68		1.03E-07
3	RT = 0.971	dT =	68.00 min			s'c =	0.7 ksf	0.267	0.261	io= 21.3	0%
initial	21.3	03/10/1999	12	46	00	105.0	100.0	57.90	46.60	1.04	9.58E-08
final	21.3	03/10/1999	13	57	00			54.31	47.71		1.03E-07
4	RT = 0.973	dT =	71.00 min			s'c =	0.7 ksf	0.269	0.259	io= 21.0	-1%
initial											
final											
5		dT =				s'c =					
initial											
final											
6		dT =				s'c =					

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE
ASTM D 5084 - 90

Project No.: 38-08E06011 | SAMPLE: Composite | Test No.: P5327

Project Name: Detrex | BENTONITE: Barakade 90 | PERCENT: +3% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-4 | Apparatus No. 1 | Stage No.: 2

Preliminary Length/Area Calculations

Lo =	2.695	in	Lo=	6.845	cm
dLc=	0.079	in	Ao =	42.40	cm2
Lc=	2.616	in	Vo =	290.23	cm3
			Lc=	6.645	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	25.52	cm3
			Vc =	264.71	cm3
Sc =	0.167	cm-1	Ac=	39.838	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or			top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes			
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used	x	Tap		Distilled			
or		Demineralized		0.005 N calcium sulfate (CaSO4)			

Equations Used

Kt = - 0.0000760 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.319

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.645 cm ε_{axial} = 2.9%

Ac = 37.824 cm2

Vc= 251.32 cm3 ε_{vol} = 13.4%

Sc = 0.176 cm-1 Sc = Lc / Ac , final

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	36.99	116.4	85.0	99.7
PreTest	27.24	124.9	98.2	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 2-5

ave K @ 20 °C: **6.27E-08** cm/sec

(io)ave = 20.3

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. °C	Date	Time hr	Time min	Time sec	Initial sc psi	Initial Ub psi	U-tube Reading Head (cm) (cc)	U-tube Reading Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.5	03/11/1999	09	31	00	105.0	100.0	52.60	42.30	1.01	6.70E-08
final	21.4	03/11/1999	10	26	00			50.63	42.92		6.84E-08
1	RT = 0.969	dT =	55.00 min			s'c =	0.7 ksf	0.149	0.147	io= 19.5	9%
initial	21.4	03/11/1999	10	29	00	105.0	100.0	52.88	42.20	0.99	6.24E-08
final	21.4	03/11/1999	11	25	00			50.93	42.83		6.37E-08
2	RT = 0.970	dT =	56.00 min			s'c =	0.7 ksf	0.147	0.149	io= 20.2	2%
initial	21.4	03/11/1999	11	28	00	105.0	100.0	52.92	42.19	1.00	6.14E-08
final	21.4	03/11/1999	12	31	00			50.78	42.87		6.28E-08
3	RT = 0.970	dT =	63.00 min			s'c =	0.7 ksf	0.162	0.161	io= 20.3	0%
initial	21.4	03/11/1999	12	34	00	105.0	100.0	52.92	42.19	0.98	6.07E-08
final	21.3	03/11/1999	13	37	00			50.80	42.88		6.22E-08
4	RT = 0.971	dT =	63.00 min			s'c =	0.7 ksf	0.160	0.164	io= 20.3	-1%
initial	21.3	03/11/1999	13	40	00	105.0	100.0	52.96	42.18	1.02	6.08E-08
final	21.3	03/11/1999	15	11	00			50.07	43.08		6.23E-08
5	RT = 0.973	dT =	91.00 min			s'c =	0.7 ksf	0.219	0.213	io= 20.4	-1%
								0.000	0		

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 | BORING: Composite / SW-101 | Test No.: P5312

Project Name: | SAMPLE: 0.5% via slurry 0% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-8 | Apparatus No. 3 | Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.719	in	Lo=	6.906	cm
dLc=	0.083	in	Ao =	42.05	cm2
Lc=	2.636	in	Vo =	290.42	cm3
			Lc=	6.695	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	26.60	cm3
			Vc =	263.82	cm3
Sc =	0.170	cm-1	Ac=	39.406	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or			top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air					x	No	Yes
4) During consolidation:	x	Top and bottom drainage or				Top	Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used	x	Tap		Distilled			
or		Demineralized		0.005 N calcium sulfate (CaSO4)			

Equations Used

Kt = - 0.0000756 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.316

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.695 cm ε_{axial} = 3.1%

Ac = 36.499 cm2

Vc= 244.35 cm3 ε_{vol} = 15.9%

Sc = 0.183 cm-1 Sc = Lc / Ac , final

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	38.25	115.7	83.7	100.0
PreTest	26.42	125.7	99.4	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **2.68E-07** cm/sec

(io)ave = 19.2

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	min	sec	Initial sc psi	Ub psi	U-tube Reading Head (cm)	Tail (cm)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.4	03/10/1999	09	15	00	105.0	100.0	59.50	49.34	1.03	2.54E-07
final	21.4	03/10/1999	09	58	00			55.08	50.70		2.66E-07
1	RT = 0.970	dT =	43.00 min			s'c =	0.7 ksf	0.332	0.323	io= 19.1	-1%
initial	21.4	03/10/1999	10	00	00	105.0	100.0	59.40	49.36	1.00	2.52E-07
final	21.4	03/10/1999	11	33	00			53.00	51.38		2.64E-07
2	RT = 0.970	dT =	93.00 min			s'c =	0.7 ksf	0.480	0.480	io= 18.9	-1%
initial	21.4	03/10/1999	11	36	00	105.0	100.0	59.72	49.26	1.02	2.58E-07
final	21.3	03/10/1999	12	44	00			53.80	51.10		2.71E-07
3	RT = 0.971	dT =	68.00 min			s'c =	0.7 ksf	0.444	0.437	io= 19.6	1%
initial	21.3	03/10/1999	12	46	00	105.0	100.0	59.50	49.34	1.02	2.57E-07
final	21.3	03/10/1999	13	53	00			53.80	51.10		2.70E-07
4	RT = 0.973	dT =	67.00 min			s'c =	0.7 ksf	0.428	0.418	io= 19.1	1%
initial											
final											
5		dT =				s'c =					
initial											
final											
6		dT =				s'c =					

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 | BORING: Composite / SW-101 | Test No.: P5315

Project Name: | SAMPLE: 0.5% via slurry 1% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-5 | Apparatus No. 5 | Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.714	in	Lo=	6.893	cm
dLc=	0.122	in	Ao =	42.53	cm2
Lc=	2.592	in	Vo =	293.12	cm3
			Lc=	6.583	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	39.53	cm3
			Vc =	253.59	cm3
Sc =	0.171	cm-1	Ac=	38.522	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or			top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used	x	Tap		Distilled			
or		Demineralized		0.005 N calcium sulfate (CaSO4)			Permeability

Equations Used

Kt = - 0.0000748 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.3223

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.583	cm	ε_{axial} =	4.5%	
Ac =	36.717	cm2			
Vc=	241.71	cm3	ε_{vol} =	17.5%	
Sc =	0.179	cm-1	Sc = Lc / Ac , final		

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	43.11	112.2	78.4	99.6
PreTest	29.33	122.9	95.0	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **1.27E-07** cm/sec

(io)ave = 20.4

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	min	sec	Initial sc psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.4	03/10/1999	09	15	00	105.0	100.0	58.50	48.04	0.97	1.30E-07
final	21.4	03/10/1999	10	00	00			55.60	49.00		1.32E-07
1	RT = 0.970	dT =	45.00 min			s'c =	0.7 ksf	0.216	0.222	io= 20.0	4%
initial	21.4	03/10/1999	10	03	00	105.0	100.0	58.70	48.00	0.98	1.24E-07
final	21.4	03/10/1999	11	36	00			53.90	49.58		1.26E-07
2	RT = 0.970	dT =	93.00 min			s'c =	0.7 ksf	0.358	0.366	io= 20.4	-1%
initial	21.4	03/10/1999	11	39	00	105.0	100.0	58.81	47.98	0.99	1.24E-07
final	21.3	03/10/1999	12	47	00			54.86	49.27		1.26E-07
3	RT = 0.971	dT =	68.00 min			s'c =	0.7 ksf	0.295	0.299	io= 20.7	-1%
initial	21.3	03/10/1999	12	49	00	105.0	100.0	58.80	47.98	1.00	1.21E-07
final	21.3	03/10/1999	13	59	00			54.83	49.26		1.24E-07
4	RT = 0.973	dT =	70.00 min			s'c =	0.7 ksf	0.296	0.296	io= 20.7	-3%
initial											
final											
5		dT =				s'c =					
initial											
final											
6		dT =				s'c =					

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 | SAMPLE: Composite | Test No.: P5329

Project Name: Detrex | BENTONITE: SW-101 | PERCENT: +3% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-8 | Apparatus No. 3 | Stage No.: 2

Preliminary Length/Area Calculations

Lo =	2.715	in	Lo=	6.896	cm
dLc=	0.088	in	Ao =	42.30	cm2
Lc=	2.627	in	Vo =	291.71	cm3
			Lc=	6.673	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	28.37	cm3
			Vc =	263.35	cm3
Sc =	0.169	cm-1	Ac=	39.467	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air			x	No		Yes	
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used	x	Tap		Distilled			
or		Demineralized		0.005 N calcium sulfate (CaSO4)			

Equations Used

Kt = - 0.0000756 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.316

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.673	cm	ε_{axial} =	3.2%	
Ac =	35.013	cm2			
Vc=	233.63	cm3	ε_{vol} =	19.9%	
Sc =	0.191	cm-1	Sc = Lc / Ac , final		

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	47.67	109.0	73.8	98.9
PreTest	31.38	121.1	92.2	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 2-5

ave K @ 20 °C: **5.82E-08** cm/sec

(io)ave = 20.5

Consol Stage-Trial No.	Temp. °C	Date	Time hr	min	sec	Initial sc psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.5	03/11/1999	09	37	00	105.0	100.0	60.00	49.17	1.01	8.02E-08
final	21.4	03/11/1999	10	29	00			57.71	49.89		8.76E-08
1	RT = 0.969	dT =	52.00 min			s'c =	0.7 ksf	0.172	0.171	io= 20.4	50%
initial	21.4	03/11/1999	10	30	00	105.0	100.0	60.05	49.15	1.00	5.84E-08
final	21.4	03/11/1999	11	27	00			58.15	49.75		6.39E-08
2	RT = 0.970	dT =	57.00 min			s'c =	0.7 ksf	0.143	0.142	io= 20.5	10%
initial	21.4	03/11/1999	11	29	00	105.0	100.0	60.00	49.17	1.02	5.33E-08
final	21.4	03/11/1999	12	32	00			58.10	49.76		5.82E-08
3	RT = 0.970	dT =	63.00 min			s'c =	0.7 ksf	0.143	0.14	io= 20.4	0%
initial	21.4	03/11/1999	12	34	00	105.0	100.0	60.05	49.15	1.01	5.22E-08
final	21.3	03/11/1999	13	37	00			58.17	49.74		5.72E-08
4	RT = 0.971	dT =	63.00 min			s'c =	0.7 ksf	0.141	0.14	io= 20.5	-2%
initial	21.3	03/11/1999	13	41	00	105.0	100.0	60.11	49.12	0.99	4.88E-08
final	21.2	03/11/1999	15	12	00			57.66	49.90		5.35E-08
5	RT = 0.974	dT =	91.00 min			s'c =	0.7 ksf	0.184	0.185	io= 20.7	-8%
								0.000	0		

Tested By: DT Reviewed By: G. Thomas

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 | BORING: Composite / Attapulgite | Test No.: P5311

Project Name: | SAMPLE: 1% via slurry 0% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-2 | Apparatus No. 7 | Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.846	in	Lo=	7.228	cm
dLc=	0.059	in	Ao =	42.38	cm2
Lc=	2.787	in	Vo =	306.31	cm3
			Lc=	7.078	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	19.05	cm3
			Vc =	287.26	cm3
Sc =	0.174	cm-1	Ac=	40.586	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or			
	x	with stones or		Stones with filter paper or		top + bottom	
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination			
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes			
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only	
5) Direction of permeant :	x	Up during or		Down during permeation			
6) Permeant: water used	x	Tap		Distilled			
or		Demineralized		0.005 N calcium sulfate (CaSO4)			

Equations Used

Kt = - 0.0000757 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.3155

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	Time min	Time sec	Initial sc psi	Initial Ub psi	U-tube Reading Head (cm) (cc)	U-tube Reading Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.6	03/10/1999	09	16	00	105.0	100.0	58.07	47.29	0.97	1.23E-07
final	21.6	03/10/1999	10	01	00			55.26	48.20		1.31E-07
1	RT = 0.965	dT =	45.00 min			s'c =	0.7 ksf	0.211	0.217	io= 19.1	1%
initial	21.6	03/10/1999	10	03	00	105.0	100.0	57.91	47.34	1.00	1.20E-07
final	21.5	03/10/1999	11	37	00			53.30	48.80		1.27E-07
2	RT = 0.967	dT =	94.00 min			s'c =	0.7 ksf	0.346	0.348	io= 18.8	-1%
initial	21.5	03/10/1999	11	39	00	105.0	100.0	58.00	47.30	0.99	1.21E-07
final	21.3	03/10/1999	12	47	00			54.22	48.50		1.30E-07
3	RT = 0.970	dT =	68.00 min			s'c =	0.7 ksf	0.284	0.286	io= 19.0	0%
initial	21.3	03/10/1999	12	50	00	105.0	100.0	58.00	47.30	0.98	1.20E-07
final	21.3	03/10/1999	13	56	00			54.33	48.48		1.29E-07
4	RT = 0.973	dT =	66.00 min			s'c =	0.7 ksf	0.276	0.281	io= 19.0	0%
initial											
final											
5		dT =				s'c =					
initial											
final											
6		dT =				s'c =					

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	7.078	cm	ε_{axial} =	2.1%	
Ac =	36.849	cm2			
Vc=	260.81	cm3	ε_{vol} =	14.9%	
Sc =	0.192	cm-1	Sc = Lc / Ac , final		

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	36.22	117.8	86.5	100.0
PreTest	25.49	127.5	101.6	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **1.29E-07** cm/sec

(io)ave = 19.0

Tested By: DT Reviewed By: G. Thomas

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 | BORING: Composite / Attapulgite | Test No.: P5314

Project Name: | SAMPLE: 1% via slurry 1% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-6 | Apparatus No. 4 | Stage No.: 3

Preliminary Length/Area Calculations

Lo =	2.707	in	Lo=	6.876 cm
dLc=	0.092	in	Ao =	42.16 cm2
Lc=	2.615	in	Vo =	289.86 cm3
			Lc=	6.642 cm
dVc = 3 Vo * (dLc/Lo)			dVc=	29.55 cm3
			Vc =	260.31 cm3
Sc =	0.169	cm-1	Ac=	39.190 cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes		
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation		
6) Permeant: water used	x	Tap		Distilled		
or		Demineralized		0.005 N calcium sulfate (CaSO4)		

Equations Used

Kt = - 0.0000773 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.3133

TEST SUMMARY

Final Specimen and Test Conditions

Lc = 6.642 cm ε_{axial} = 3.4%

Ac = 37.184 cm2

Vc= 246.99 cm3 ε_{vol} = 14.8%

Sc = 0.179 cm-1 Sc = Lc / Ac , final

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	37.06	117.2	85.5	100.0
PreTest	26.26	126.7	100.3	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 1-4

ave K @ 20 °C: **1.32E-07** cm/sec

(io)ave = 19.9

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	min	sec	Initial sc psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.7	03/10/1999	09	17	00	105.0	100.0	56.80	46.53	0.97	1.29E-07
final	21.7	03/10/1999	10	02	00			54.00	47.43		1.31E-07
1	RT = 0.963	dT =	45.00 min			s'c =	0.7 ksf	0.214	0.220	io= 19.4	-1%
initial	21.7	03/10/1999	10	04	00	105.0	100.0	57.10	46.48	1.01	1.29E-07
final	21.6	03/10/1999	11	38	00			52.21	48.00		1.31E-07
2	RT = 0.964	dT =	94.00 min			s'c =	0.7 ksf	0.374	0.372	io= 20.1	0%
initial	21.6	03/10/1999	11	40	00	105.0	100.0	57.06	46.50	1.02	1.31E-07
final	21.4	03/10/1999	12	48	00			53.10	47.72		1.33E-07
3	RT = 0.968	dT =	68.00 min			s'c =	0.7 ksf	0.303	0.298	io= 20.0	1%
initial	21.4	03/10/1999	12	50	00	105.0	100.0	57.10	46.48	1.00	1.29E-07
final	21.4	03/10/1999	14	02	00			52.99	47.77		1.32E-07
4	RT = 0.970	dT =	72.00 min			s'c =	0.7 ksf	0.315	0.315	io= 20.1	0%
initial											
final											
5		dT =				s'c =					
initial											
final											
6		dT =				s'c =					

PERMEABILITY TEST: FALLING HEAD - CONSTANT VOLUME U-TUBE

ASTM D 5084 - 90

Project No.: 38-08E06011 | SAMPLE: Composite | Test No.: P5328

Project Name: Detrex | ADDITIVE: Attapulgite | PERCENT: +3% dry

Specimen - Apparatus set-up - Test Information | Cell No. H-2 | Apparatus No. 7 | Stage No.: 2

Preliminary Length/Area Calculations

Lo =	2.741	in	Lo=	6.962	cm
dLc=	0.100	in	Ao =	42.25	cm2
Lc=	2.641	in	Vo =	294.14	cm3
			Lc=	6.708	cm
dVc = 3 Vo * (dLc/Lo)			dVc=	32.19	cm3
			Vc =	261.94	cm3
Sc =	0.172	cm-1	Ac=	39.050	cm2

1) Specimen Tested in :	x	Triaxial Cell or		Compaction Mold or		
	x	with stones or		Stones with filter paper or		top + bottom
2) Specimen orientation for:	x	Vertical or		Horizontal permeability determination		
3) During saturation: Water flushed up sides of specimen to remove air	x	No		Yes		
4) During consolidation:	x	Top and bottom drainage or		Top		Bottom only
5) Direction of permeant :	x	Up during or		Down during permeation		
6) Permeant: water used	x	Tap		Distilled		
or		Demineralized		0.005 N calcium sulfate (CaSO4)		

Equations Used

Kt = - 0.0000757 * Sc/dT(min) * ln (ho/hf)

RT = (-0.02452*(ave. temp in C) + 1.495)

K @ 20 °C = RT * Kt TubeC= 1.3155

TEST SUMMARY

Final Specimen and Test Conditions

Lc =	6.708	cm	ε_{axial} =	3.6%	
Ac =	38.044	cm2			
Vc=	255.19	cm3	ε_{vol} =	13.2%	
Sc =	0.176	cm-1	Sc = Lc / Ac , final		

	w (%)	γ_t (pcf)	γ_d (pcf)	S (%)
Initial	37.87	116.6	84.6	100.0
PreTest	28.09	124.8	97.5	100.0

HYDRAULIC CONDUCTIVITY SUMMARY

Averages for trials: 2-5

ave K @ 20 °C: **8.98E-08** cm/sec

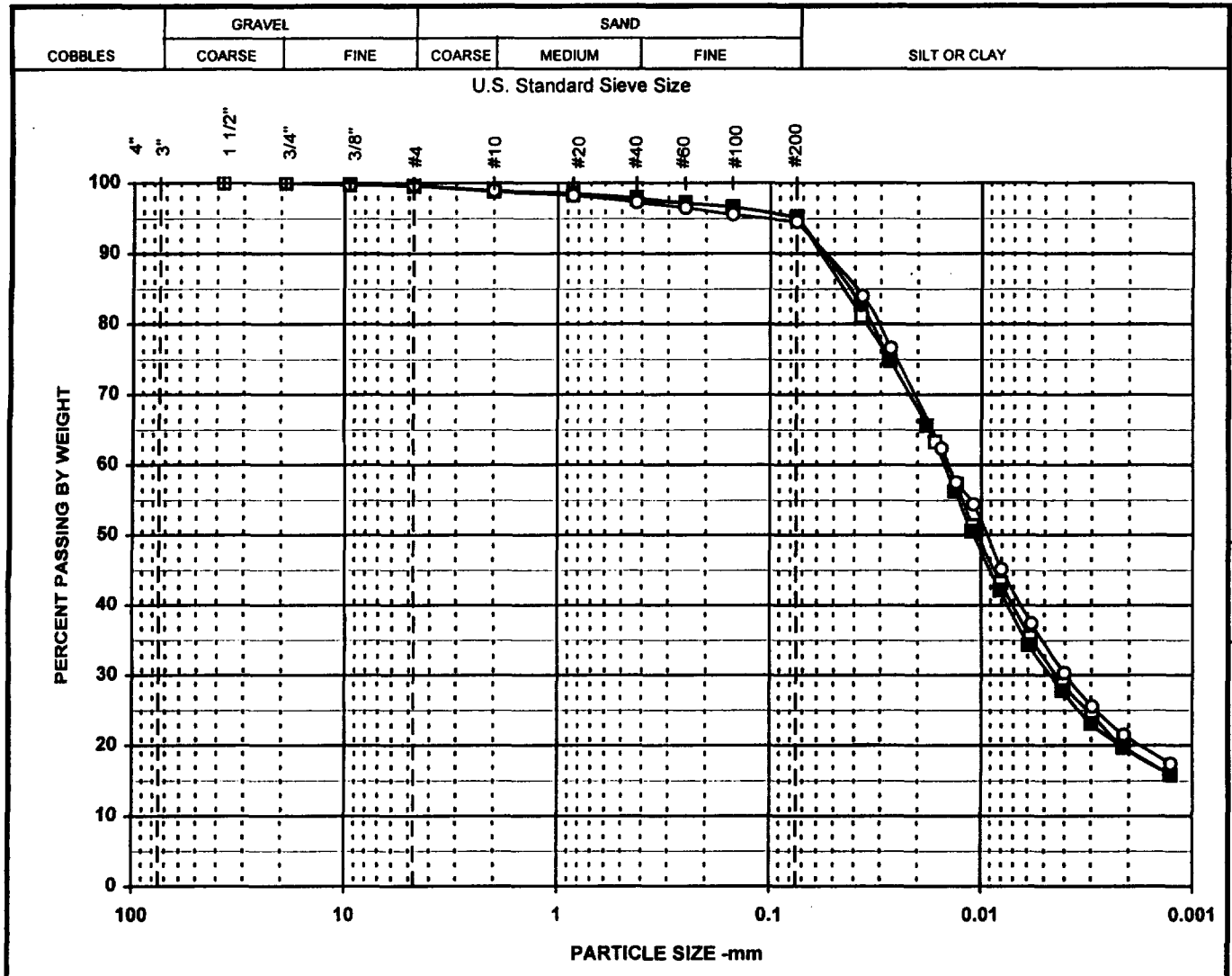
(io)ave = 19.2

Tested By: DT Reviewed By: G. Thomas

Consol Stage-Trial No.	Temp. ° C	Date	Time hr	min	sec	Initial sc psi	Ub psi	U-tube Reading Head (cm) (cc)	Tail (cm) (cc)	Flow in/out gradient	Permeability Preliminary Final at 20°C cm/sec Dev. from Ave.
initial	21.6	03/11/1999	09	32	00	105.0	100.0	57.60	47.45	1.03	9.44E-08
final	21.5	03/11/1999	10	27	00			55.06	48.23		9.37E-08
1	RT = 0.967	dT =	55.00 min			s'c =	0.7 ksf	0.191	0.186	io= 19.0	4%
initial	21.5	03/11/1999	10	30	00	105.0	100.0	57.70	47.40	0.98	9.15E-08
final	21.5	03/11/1999	11	26	00			55.15	48.22		9.09E-08
2	RT = 0.968	dT =	56.00 min			s'c =	0.7 ksf	0.192	0.195	io= 19.3	1%
initial	21.5	03/11/1999	11	29	00	105.0	100.0	57.70	47.40	1.00	9.05E-08
final	21.4	03/11/1999	12	32	00			54.92	48.28		9.00E-08
3	RT = 0.969	dT =	63.00 min			s'c =	0.7 ksf	0.209	0.210	io= 19.3	0%
initial	21.4	03/11/1999	12	34	00	105.0	100.0	57.70	47.40	0.99	9.01E-08
final	21.3	03/11/1999	13	37	00			54.93	48.28		8.99E-08
4	RT = 0.971	dT =	63.00 min			s'c =	0.7 ksf	0.208	0.210	io= 19.3	0%
initial	21.3	03/11/1999	13	40	00	105.0	100.0	57.54	47.46	1.01	8.86E-08
final	21.2	03/11/1999	15	11	00			54.00	48.57		8.86E-08
5	RT = 0.974	dT =	91.00 min			s'c =	0.7 ksf	0.266	0.264	io= 18.9	-1%
								0.000	0.000		

Attachment 4-F

Particle Size Distribution



Symbol	□	■	○
Boring	RMI	S	W
Sample	NA		
Spec			
Depth			
% +3"			
% Gravel	0.4	0.5	0.3
% SAND	4.4	4.3	5.2
% FINES	95.2	95.3	94.5
% -2μ	19	19	21
Cc			
Cu			
LL	26	26	29
PL	16	17	18
PI	10	9	11
USCS	CL	CL	CL
w (%)			

Particle Size	PERCENT FINER		
(Sieve #)	□	■	○
4"			
3"			
1 1/2"	100.0		
3/4"	100.0	100.0	100.0
3/8"	99.7	99.8	99.7
4	99.6	99.5	99.7
10	98.8	99.0	98.9
20	98.3	98.6	98.2
40	97.7	97.9	97.3
60	97.2	97.2	96.5
100	96.6	96.6	95.6
200	95.2	95.3	94.5

SYMBOL	DESCRIPTION AND REMARKS
□	gray brown silty CLAY, trace m-f sand.
■	brown silty CLAY, trace m-f sand.
○	brown silty CLAY, trace m-f sand.

PARTICLE SIZE DISTRIBUTION

Detrex

Project No.		Figure
8E06011	November 1999	

URS Greiner Woodward Clyde

Siev1.xls 12/21/1999

Project No. 8E06011
Plotted By: CMJ
Reviewed ByGET
Figure No.:
Project: Detrex
URS or GSI URS

BORING RMI
SAMPLE NA
SPECIMEN
DEPTH

Description: gray brown silty CLAY, trace m-f sand.
LL 26
PL 16
Fines CL
USCS CL fines

	% +3"	0.0
	% Gravel	0.4
	% SAND	4.4
	% FINES	95.2
	D60	0.000
	D30	0.004
	D10	0.000
	%<0.002	19.21
	Cu	
	Cc	

	Total (1)	Oversize		Wet Scalped	Total Sample	Split(1)	Split(1)	Split (2)	+200 Wash		Hydrometer
Split after Series No:			5			5	7	13	13		7
Split Size			3/8"			3/8"	10	200			10
Wet + Tare				21780							-200 Wash
Dry + Tare	-----		194.25		18238.52	295.83	52.36		134.65		291.99
Tare			129.53			132.95			132.48		236.8
				% passing	100%	99.70%	98.80%	95.17%		Defloc.	5
Dry Wt		0	64.72	18173.8	18238.52328	162.88	52.36	0	2.17		50.19
										Total	52.36

Wet + Tare	328.15
Dry + Tare	295.83
Tare	132.95
w	19.84%

a	b	c		d	e	f	g	h	i	j	k		
Series No.	Sieve No.	Sieve (mm)		Nest 1	Nest 2		Cumulative Wgt. Retained (gm)	D (mm)	% finer N'	D60	D30	D10	0.002
1	4"		101.6				0	101.6					
2	3"		75				0	75					
3	1 1/2"		37.5	0			0	37.5	100.0				
4	3/4"		19	8.87			8.87	19	100.0				
5	3/8"		9.5	54.22			54.22	9.5	99.7				
6	4		4.75	0.21			0.21	4.75	99.6				
7	10		2	1.48			1.48	2	98.8				
8	20		0.85	0.27			0.27	0.85	98.3				
9	40		0.425	0.58			0.58	0.425	97.7				
10	60		0.25	0.86			0.86	0.25	97.2				
11	100		0.15	1.17			1.17	0.15	96.6				
12	200		0.075	1.92			1.92	0.075	95.2				
13	Pan			2.12			2.12						

% Total Soil in Hydrometer =	98.80			
Mass Dry Soil in cylinder =	52.36			
Specific Gravity =	2.72		0.00943	
a =	0.986			
Total % finer Factor=	1.860			
Ave. Temp =	22.53	Gw=	0.99768	
k=	0.01294	n	0.00942	
F	5.7950	1.9		
m	0.164			

Date	Time	Elapsed Time (min)	Temp (oC)	Soil (2) R	Water (3) Rw	L				
02/18/1999	8:54	0	23.1				0.075	95.17		
		1	23.1	49.2	5.6	8.226	0.0371	81.1		
		2	23.1	45.8	5.6	8.784	0.0271	74.8		
		6	23	39.6	5.6	9.801	0.0165	63.3		
		10	23	36.4	5.6	10.325	0.0131	57.3	0.014682	
		15	23	33.2	5.6	10.850	0.0110	51.3		
		30	22.9	28.8	5.6	11.572	0.0080	43.2		
		60	22.7	24.8	5.8	12.228	0.0058	35.3		
		130	22.3	21.3	5.9	12.802	0.0041	28.7		0.0044187
		250	21.9	19	5.9	13.179	0.0030	24.4		
02/18/1999	17:27	513	21.6	16.1	5.5	13.655	0.0021	19.7		
02/19/1999	9:13	1459	21.2	14.1	5.6	13.983	0.0013	15.8		19.2081

Project No.	8E06011		BORING	S		Description: brown silty CLAY, trace m-f sand.					% +3"	0.0
Plotted By:	CMJ		SAMPLE			LL	26				% Gravel	0.5
Reviewed By	GET		SPECIMEN			PL	17				% SAND	4.3
Figure No.:			DEPTH			Fines	CL				% FINES	95.3
Project:	Detrex					USCS	CL	fines			D60	0.000
URS or GSI	URS										D30	0.005
	Total (1)	Oversize	Wet Scalped	Total Sample	Split(1)	Split(1)	Split (2)	+200 Wash		Hydrometer	D10	0.000
Split after Series No:		5			5	7	13	13		7	%<0.002	19.23
	Split Size	3/8"			3/8"	10	200			10	Cu	
Wet + Tare			19450		----------	----------	----------	----------		-200 Wash	Cc	
Dry + Tare	-----	169.39		16313.09	328.93	51.19		136.35		290.73		
Tare		131.65			132.63			134.29		236.6		
			% passing	100%	99.81%	98.98%	95.27%		Defloc.	5		
Dry Wt	0	37.74	16275.4	16313.09274	196.3	51.19	0	2.06		49.13		
									Total	51.19		
Wet + Tare			367.22									
Dry + Tare			328.93									
Tare			132.63									
w			19.51%									

a	b	c	d	e	f	g	h	i	j	k		
Series No.	Sieve No.	Sieve (mm)	Nest 1	Nest 2		Cumulative Wgt. Retained (gm)	D (mm)	% finer N'	D60	D30	D10	0.002
1	4"	101.6				0	101.6					
2	3"	75				0	75					
3	1 1/2"	37.5				0	37.5					
4	3/4"	19	0			0	19	100.0				
5	3/8"	9.5	31.25			31.25	9.5	99.8				
6	4	4.75	0.54			0.54	4.75	99.5				
7	10	2	1.62			1.62	2	99.0				
8	20	0.85	0.21			0.21	0.85	98.6				
9	40	0.425	0.57			0.57	0.425	97.9				
10	60	0.25	0.92			0.92	0.25	97.2				
11	100	0.15	1.23			1.23	0.15	96.6				
12	200	0.075	1.92			1.92	0.075	95.3				
13	Pan		2.04			2.04						

% Total Soil in Hydrometer =	98.98			
Mass Dry Soil in cylinder =	51.19			
Specific Gravity =	2.72		0.00953	
a =	0.986			
Total % finer Factor=	1.907			
Ave. Temp =	22.10	Gw=	0.99778	
k=	0.01301	n	0.00952	
F	5.7950	1.9		
m	0.164			

Date	Time	Elapsed Time (min)	Temp (oC)	Soil (2) R	Water (3) Rw	L					
		0	22.4				0.075	95.27			
		1	22.4	49	5.6	8.259	0.0374	82.7			
		2	22.4	45	5.6	8.915	0.0275	75.1			
		5	22.4	40	5.6	9.735	0.0181	65.6			
		10	22.4	35.1	5.6	10.539	0.0134	56.2	0.015279		
		15	22.4	32.1	5.6	11.031	0.0112	50.5			
		30	22.3	27.7	5.6	11.752	0.0081	42.1			
		59	22.2	23.8	5.8	12.392	0.0060	34.3			
		129	22	20.5	5.9	12.933	0.0041	27.8		0.0047329	
		249	21.8	18	5.9	13.343	0.0030	23.1			
		512	21.6	15.9	5.5	13.687	0.0021	19.8			
		1458	21.2	13.9	5.6	14.015	0.0013	15.8			19.23404

Project No.	8E06011		BORING	W		Description: brown silty CLAY, trace m-f sand.						% +3"	0.0
Plotted By:	CMJ		SAMPLE			LL	29					% Gravel	0.3
Reviewed By	GET		SPECIMEN			PL	18					% SAND	5.2
Figure No.:			DEPTH			Fines	CL					% FINES	94.5
Project:	Detrex					USCS	CL	fines				D60	0.000
URS or GSI	URS											D30	0.004
	Total (1)	Oversize	Wet Scalped	Total Sample	Split(1)	Split(1)	Split (2)	+200 Wash		Hydrometer		D10	0.000
Split after Series No:		5			5	7	13	13		7		%<0.002	20.95
	Split Size	3/8"			3/8"	10	200			10		Cu	
Wet + Tare			20070							-200 Wash		Cc	
Dry + Tare	-----	185.83		16650.25	315.28	52.71		133.05		303.84			
Tare		132.85			129.46			130.34		248.84			
			% passing	100%	99.73%	98.92%	94.51%		Defloc.	5			
Dry Wt	0	52.98	16597.3	16650.2537	185.82	52.71	0	2.71		50			
									Total	52.71			
Wet + Tare			354.16										
Dry + Tare			315.28										
Tare			129.46										
w			20.92%										

a	b	c	d	e	f	g	h	i	j	k		
Series No.	Sieve No.	Sieve (mm)	Nest 1	Nest 2		Cumulative Wgt. Retained (gm)	D (mm)	% finer N'	D60	D30	D10	0.002
1	4"	101.6				0	101.6					
2	3"	75				0	75					
3	1 1/2"	37.5				0	37.5					
4	3/4"	19	0			0	19	100.0				
5	3/8"	9.5	44.42			44.42	9.5	99.7				
6	4	4.75	0.14			0.14	4.75	99.7				
7	10	2	1.52			1.52	2	98.9				
8	20	0.85	0.36			0.36	0.85	98.2				
9	40	0.425	0.87			0.87	0.425	97.3				
10	60	0.25	1.29			1.29	0.25	96.5				
11	100	0.15	1.79			1.79	0.15	95.6				
12	200	0.075	2.35			2.35	0.075	94.5				
13	Pan		2.71			2.71						

% Total Soil in Hydrometer =	98.92			
Mass Dry Soil in cylinder =	52.71			
Specific Gravity =	2.72		0.00951	
a =	0.986			
Total % finer Factor=	1.850			
Ave. Temp =	22.16	Gw=	0.99776	
k=	0.01300	n	0.00950	
F	5.7950	1.9		
m	0.164			

Date	Time	Elapsed Time (min)	Temp (oC)	Soil (2) R	Water (3) Rw	L					
		0	22.4				0.075	94.51			
		1	22.4	51	5.6	7.931	0.0366	84.0			
		2	22.4	47	5.6	8.587	0.0269	76.6			
		7	22.4	39.3	5.6	9.850	0.0154	62.4			
		10	22.4	36.7	5.6	10.276	0.0132	57.5	0.014317		
		15	22.4	35	5.6	10.555	0.0109	54.4			
		30	22.4	30	5.6	11.375	0.0080	45.1			
		61	22.3	26	5.8	12.031	0.0058	37.4			
		131	22.1	22.3	5.9	12.638	0.0040	30.3			
		251	21.9	19.7	5.9	13.064	0.0030	25.5		0.0039593	
		514	21.7	17.1	5.5	13.491	0.0021	21.5			
		1460	21.4	15	5.6	13.835	0.0013	17.4			20.95388

ATTACHMENT 5
Community Relations Plan

Community Relations Plan
Detrex Source Control Remedial Action

Community relations is an important aspect of the Detrex Remedial Action. Detrex Corporation hereby commits to cooperating with and providing support, as requested, to U.S. EPA's community relations activities. The following persons are points of contact should there be a situation of interest to the community and/or the media:

Mr. Thomas Steib	Operations Manager	440-997-6131
Mr. Thomas Doll	Site Manager	440-997-6131